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A

MONOGRAPH

OF THE

BRITISH MARINE ANNELIDS.

VOL. III. PART I.—TEXT.

POLYCHÆTA.

OPHELIIDÆ TO AMMOCHARIDÆ.

BY

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TEMPORARY PREFACE.

A LARGER number of species is dealt with in this volume than in the last, but as many were procured in deep water, for instance, by Dr. Gwyn Jeffreys and Canon Norman in Shetland, or captured under difficult circumstances, it has not been possible to include so many coloured figures as could have been wished. Yet in this part economically valuable forms, such as the Arenicolids and Spionids, brightly phosphorescent types like *Chætopterus*, the most cosmopolitan of all the boring groups, viz. the Polydoræ and Dodecaceridæ, the complex and physiologically interesting *Magelona* and the Capitellidæ, and, lastly, the numerous and peculiar family of the Maldanids, fall to be considered.

While some in this section lack beauty of coloration in contrast with the elegant Phyllodocidæ, they, for example, *Chætopterus* and *Magelona*, surpass these in the remarkable complexity of outline, or in special modification of internal structure. The coloured figures by my late sister, Mrs. Albert Günther, and those by Miss Walker, speak for themselves.

To my colleagues of the Old and the New World I am much indebted for many valuable works and memoirs pertaining to the Marine Annelids, and especially of the families now under consideration. Whilst a list of these will probably be given in the final part, it is right now to record the loss which everyone interested in the group has felt by the death of the veteran naturalist, Prof. Kinberg, of Stockholm. As a pioneer his name is worthy of honourable remembrance along with those of Rathke, Grube, George Johnston, De Quatrefages, Malmgren, and Langerhans.

The kind aid of Canon Norman and the late Dr. Gwyn Jeffreys in their dredging in former years in the Zetlandic seas has again to be recorded. To Dr. Allen, of the Plymouth Marine Laboratory, for southern specimens, to Prof. Arwidsson, of Upsala, for aid with the Maldanidæ, to Mr. Southern for his courtesy in forwarding Irish specimens, and to Mr. Arnold Watson for a coloured and other figures of *Owenia*, my special thanks are due.

I have also, as on former occasions, to acknowledge the courtesy of the Librarians of the Linnean, the Royal, and the Zoological Societies of London, of the British Museum (Natural History), as well as that of the Librarians of the University of St. Andrews.

My thanks are further due to Miss Ada H. Walker for her skilful and patient work with pencil and brush. Unfortunately one or two forms were found to be British at the last moment, and hence the illustrative figures were entered with difficulty in the plates, whilst others have to be delayed for future publication.

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A grant of £50 was made by the Royal Society in aid of the coloured plates, and the same amount by the Carnegie Trust, who also generously contributed to the original artistic work carried on at the Marine Laboratory.

To Mr. Hopkinson, the Secretary of the Society, I am much indebted for constant advice and attention, especially in connection with blanks in the references. The trouble he cheerfully took to render these references as complete as possible, as well as the labour devoted to the proof-sheets and index, deserves my cordial acknowledgments.

W. C. M.

Gatty Marine Laboratory,
St. Andrews;
November, 1914.

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EXPLANATION OF LETTERS USED IN THE TEXT-FIGURES.

b. Dorsal bristles.
b′. Ventral bristles.
bd. Dorsal division foot.
bv. Ventral division foot.
c. and *so*. Segmental organ.
co. Ciliated organ (cœlomostome).
d. Alimentary canal.
d′. Cæca of canal.
dc. Dorsal cirrus.
dm. Dorsal longitudinal muscles.
dv. Dorsal blood-vessel.
hp. Hypoderm.
iso. Internal end of nephridium with solenocytes.
nc. Nerve-cords.
np. Nephridiopore.
npc. Nephridial canal.
om. Oblique muscle.
ov. Ova.
sp. Spine.
sol. Solenocytes.
vc. Ventral cirrus.
vm. Ventral longitudinal muscles.
vv. Ventral blood-vessel.

FAMILIES, GENERA, AND SPECIES OF THE BRITISH MARINE ANNELIDS.

(ANNELIDA POLYCHÆTA, *continued.*)

Family XV.—Opheliidæ (Ophelracea), *Grube*, 1851.

The head is little differentiated, more or less elongated and conical, with ciliated nuchal organs protractile from pits posteriorly. Eyes present or absent. Buccal segment without tentacles, though it has bristles, and a setigerous process, or occasionally none. Proboscis protrusible, patelliform. The body is comparatively short, of two regions, ringed, rounded dorsally, grooved ventrally, occasionally slightly tapered toward each extremity (fusiform) and iridescent, the anus having various processes—sometimes valvular. Only the anterior region with dissepiments. Branchiæ in the form of simple cirri, and anterior or posterior in position, sometimes distributed throughout the entire length.

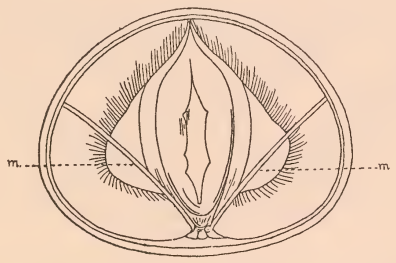

Fig. 95.—Transverse section of *Polygordius apogon*. *m*, oblique muscle.

The feet are biramous, not conspicuous, sometimes indistinct or absent, and carry fascicles of simple bristles; occasionally with a cirriform lobe.

Inhabitants of sand or mud, in which they burrow.

The structure of the body-wall in this family presents an interesting series of steps from the condition in *Polyophthalmus* to that in *Ammotrypane*. In *Polyophthalmus* the body-wall approaches that of *Polygordius* in its general features, as pointed out long ago[1]; indeed, a section of the latter may well be taken as the initial stage in the series, the oblique muscles (*m*) being slender, and passing from a little below the mid-lateral region to the ventral nerve-cords (Fig. 95). These muscles, from their slenderness, are unable to affect the contour of the body-wall in this form, else they would by their contraction mark off a ventro-lateral area on each side, as happens in *Polyophthalmus* (Fig. 96). Externally

[1] 'Proc. Roy. Soc. Edinb.,' 1873–74, vol. viii, p. 386, and 'Ann. Nat. Hist.,' ser. 4, vol. xvi, 1875, p. 369, with 2 text-figs.

is the translucent cuticle with a thin layer of granular hypoderm beneath, the basement-layer between this and the muscles being scarcely visible throughout the greater part of the body-wall. The dorsal longitudinal muscles form a layer enveloping about three-fourths of the body, each muscle being thinner toward the mid-dorsal line, where it meets its fellow of the opposite side, and increasing in bulk as it approaches the oblique muscle, above which a process passes a short distance inward. The oblique muscles are of great strength, and slope inward and downward, to be attached below and at the side of the nerve-cords, a few fibres even appearing above the flattened area in the posterior region. This powerful muscle cuts off, as it were (in transverse section), the segment containing the ventral longitudinal muscle with a portion of the cœlom on each side, and

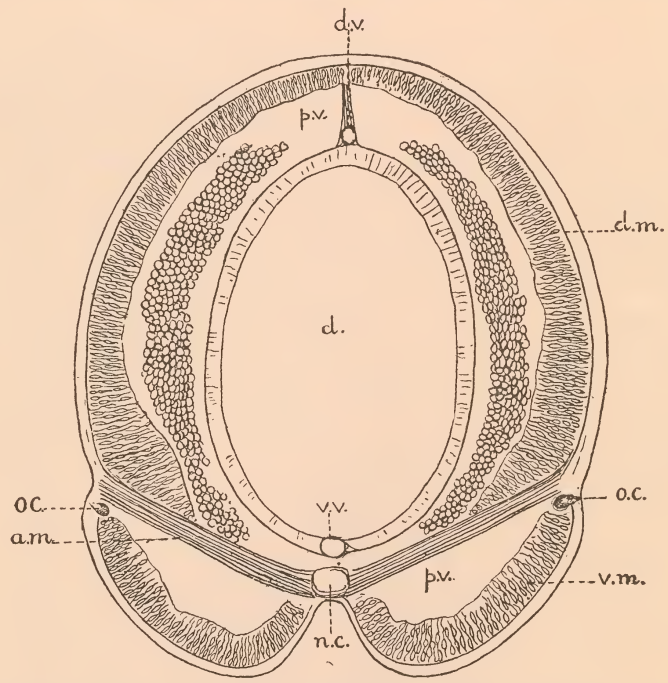

Fig. 96.—Transverse section of the anterior third of *Polyophthalmus pictus*, Dujardin. *oc*, ocelli. Other letters as before.

it is proportionally much less than the dorsal longitudinal muscle. The nerve-cords lie in the middle line, and have only a thin basement-tissue, a very narrow layer of hypoderm, and the cuticle externally. The cylindrical alimentary canal in the middle of the body has externally a firm investment apparently containing some circular or elastic fibres, and beneath is a finely granular glandular layer, a longitudinal muscular layer, and an inner coat of columnar cells. Strong suspensory fibres fix it to the mid-dorsal line, and in the mid-ventral line beneath is the ventral blood-vessel.[1] The cœlomic space in the example examined is filled with large granular nucleated cells, apparently ova, and they also occupy the spaces between the oblique and the ventral longitudinal muscles. A somewhat different condition is observed in the section of an *Ophelia*, from the cruise of the 'Valorous,' in which (Fig. 97) the oblique muscles form great sheets externally to the nerve-cords, and cut off the ventral longitudinal muscles in the projecting region on each side.

[1] Claparède indeed held that the cœlom was divided into three longitudinal chambers, as in the Terebellidæ.

In this, as in the other forms, the dorsal and ventral vascular trunks and their branches are conspicuous. A vessel leaves the latter on each side and passes to the branchia.

The next stage in the transformation of the body-wall is seen in *Ophelia* (*e.g. O. limacina*), in which, while the oblique muscles are wide apart in front—with the nerve-cords in the middle of the long interval between the ventral longitudinal muscles, the cords having a granular area, a series of transverse fibres, the hypoderm, and the cuticle internally—they wholly alter their position in the region behind. The oblique muscles,[1] in their progress backward, gradually increase in bulk, touch each other in the mid-ventral line, push up the nerve-cords, and passing upward and outward as a wide sheet, leave a broad flap beyond, *viz.*, the ventral longitudinal muscle on each side (Fig. 98). Soon, however, the muscle becomes shorter from side to side, but elongated vertically so as to convert the lateral lamella into a pedicle with an enlarged end containing the powerful ventral longitudinal muscle. The outline ventrally in section

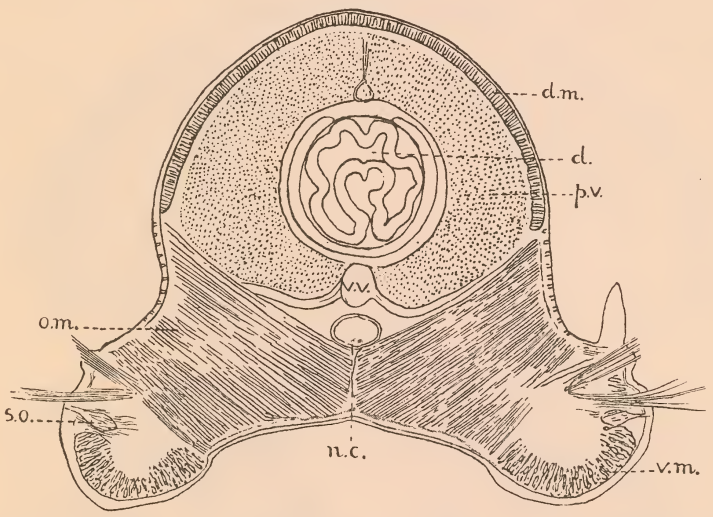

Fig. 97.—Transverse section of *Ophelia* A., dredged by the 'Valorous.' *d*, alimentary canal; *dm*, dorsal longitudinal muscle; *nc*, nerve-cord; *om*, oblique muscle; *pv*, cœlomic cavity filled with male elements; *so*, segmental organ; *vm*, ventral longitudinal muscle; *vv*, ventral blood-vessel.

thus shows an arch in the middle between two broadly clavate pillars, the inner ends of the upper fibres of the oblique muscles touching in the middle line, the fibres being attached to a pointed process of the cuticle which extends inward from the surface, and having the nerve-cords above them. In this region the outline of the nerve-area is ovoid, and more than one neural canal appears toward the centre. Externally is a tough capsule and strands of neuroglia. The dorsal arch of the body is formed by the dense cuticle, beneath which is a thin but firm layer apparently hypodermic, though basement-tissue elements may also be incorporated internally. Within the foregoing is the moderately developed dorsal longitudinal muscles, which fuse in the mid-dorsal line, and pass downward on each side to the edge of the oblique muscle. The alimentary canal in section anteriorly presents a tough homogeneous external layer with a vacuolated external portion ventrally, a basement layer, and a thick internal coating of columnar cells. In some the cœlom is distended with ova and in others with sperms.

[1] In the earlier paper in the 'Proc. Roy. Soc. Edinb.' for 1876, these muscles were termed vertical in *Ophelia*, but a more extended inquiry would seem to point to their being the oblique.

Sections of the segmental organ occur in that portion of the cœlom between the lower border of the oblique muscle and the ventral longitudinal, and to the exterior are attached groups of early ova. The duct from the organ opens to the exterior on the outer and upper border of each ventral pedicle, and, so far as appearances go, near the bristle-tuft, and in certain forms near the cirrus (branchia).[1] At least stained granules had exuded at this point, and though the hypoderm is thickened over an area below the bristles, no aperture could be demonstrated. From the size of the canal it would seem to be capable of transmitting the ova. In the specially thickened cuticle of the arch and inner sides of the ventral pedicles, fan-like processes passed from the hypoderm to the surface in groups of five or six or more, as if pores existed at these points. Occasionally they occurred in the thick cuticle on the outer surface of the pedicle. These may, however, have been due to the effects of preparation, but their regularity is interesting.

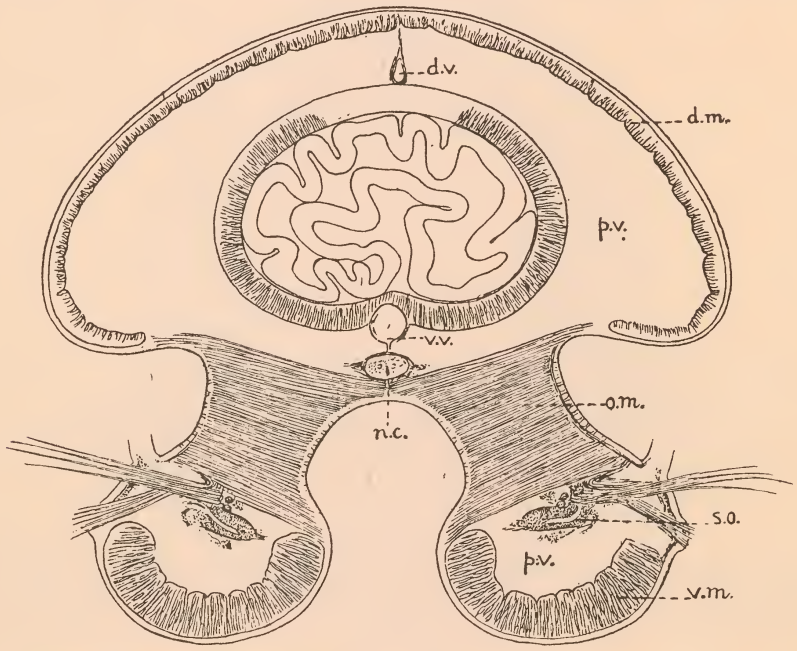

Fig. 98.—Transverse section of the body-wall of *Ophelia limacina*, H. Rathke.

A still further modification occurs in *Ammotrypane*[2] (Fig. 99) in which the oblique muscles seem to have split into two divisions, the upper (*o.m.*), much modified, passes straight across the narrowed body-wall from side to side and separates the ventral lobes containing the ventral longitudinal muscles and other parts, whilst a short but powerful slip (*o.m.'*) extends from the lateral margin on each side of the nerve-area to the opposite edge of the raphe of the ventral longitudinal muscle and to the firm wall at its inner border. Such, perhaps, may represent only a continuation of the metamorphosed oblique muscle which is prevented from joining the other fibres by the nerve-area in the centre that abuts closely on the lower fibres of the muscle of the pedicle, and, besides, a thin hypodermic area has an incurvation, with the cuticle ventrally, at each side. A distinct neural canal occurs at the upper end of the nerve-area. The lateral region is

[1] *Ophelia A*, 'Valorous' Exped.

[2] 'Proc. Roy. Soc. Edinb.,' vol. ix, 1876–7, p. 377.

lobate or pear-shaped in transverse section, and has externally a coating of tough cuticle somewhat thinner than that covering the pedicle above. A distinct layer of granular hypoderm, thickest near the middle line and tapering off at each side, lies on the ventral surface, and thickenings occur at intervals on the upper edge near the setigerous process, the powerful ventral longitudinal muscles being bent in the form of a U in each space—commencing with a rounded end next the ventral muscular slip, the upper limb of the U being shorter and more pointed. As in other forms the ova and perivisceral fluid penetrate into the area, and the setigerous process and cirrus arise above its inner and upper edge close to the pedicle. The cavity also contains the segmental organ (*s. o.*), which apparently opens on the external border, probably in a similar manner to that of *Ophelia*. The upper region of the body is somewhat ovoid in section with a peak in the mid-dorsal line. It is enveloped by a firm cuticular coat, a granular hypoderm occurring as a distinct layer beneath, and thick on the dorsal arch on each side, a still greater,

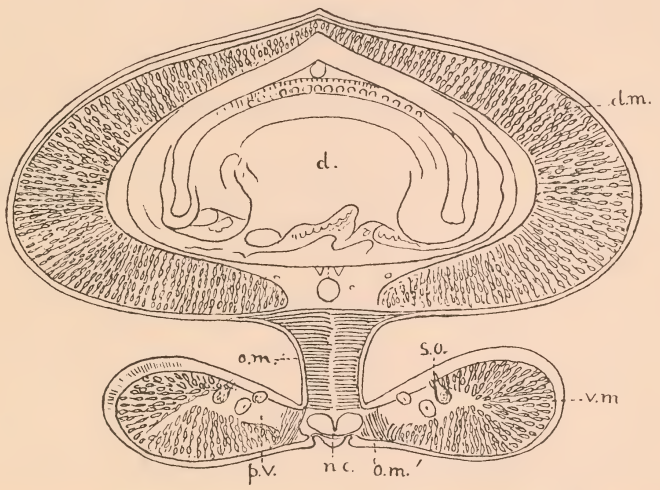

Fig. 99.—Transverse section of the body-wall of *Ammotrypane aulogaster* in the anterior region.

though limited thickening occurring ventrally as it joins the pedicle. The extensive and powerful dorsal longitudinal muscles begin on each side of the mid-dorsal line, and gradually increase in bulk to the lateral region, indeed, each remains a large muscle till it is slightly tapered as it touches the upper and outer fibres of the oblique muscle in the pedicle. The enclosed area contains the much folded anterior region of the alimentary canal, which has a corneous layer and on the dorsal arch a reticulated belt. The contents of the gut include fine mud with a vast number of diatoms, radiolarians, sponge-spicules, and other minute organisms.

In the middle region of the body the pedicle—broader above and narrower beneath —is considerably shorter and proportionately wider, but the other parts retain the same relations.

Claparède was of opinion that in the Opheliidæ (including *Polyophthalmus*) the oblique muscles attain their maximum development.

The blood in the Opheliidæ has rounded corpuscles, which Claparède saw passing along the main trunks, but which were too large to enter the minute branches in the branchiæ. The flattened perivisceral corpuscles show pseudopodia; moreover, some have a

chitinous (?) thread with spatulate ends passing through their centre—probably connected with excretion.

Attention was drawn by the author in 1875[1] to the interesting resemblances between the structure of the body-wall in this group and in *Polygordius* (*e. g. Linotrypane apogon*).

Savigny (1820) mistook the head for the tail of this group, an error corrected by Œrsted, though long before the right interpretation was made by Delle Chiaje, Sars, and G. Costa. The relationships were more fully alluded to by Claparède (1868).

De Blainville[2] included *Ophelia* along with *Aonie* and *Aglaura* in his third order, Homocriciens, and in the section *Microcères*. No advance was made by this arrangement, and he also described the anterior as the posterior end in *Ophelia*.

Audouin and Milne Edwards (1834) placed the Opheliidæ as one of the genera of their "Ariciens," under which they also ranged the Ariciidæ, the Cirratulidæ, and certain Spionidæ. In their remarks on *Ophelia* they correctly demur to the view of Savigny that antennæ (tentacles) are present, but they describe the proboscis as provided with thirteen or fourteen tentacles, whereas, so far as can be observed, the margin is only frilled in perfect examples. They also interpreted the dorsal cirrus as a ventral one. On the whole, they thought the organisation of the group so peculiar that it nearly approached the Terricolous annelids.

In his original description H. Rathke (1843) compared the glistening elastic skin of the Opheliidæ with that of the Nematoids and Nereids.

The first family under Grube's second Tribe Limivora (1851) was the Opheliacea, and he associated *Scalibregma* with *Ophelia*, *Ammotrypane*, *Travisia*, and *Eumenia*.

De Quatrefages (1865) placed this family after the Scalibregmidæ, and was inclined to think the type intermediate between the errant and the sedentary annelids, approaching the Arenicolidæ on the one hand and the Ariciidæ on the other. Moreover, he made a distinct family for the Polyophthalmea, which he relegated to the errant annelids—after the Glyceridæ, at the end of the series; yet he pointed out certain affinities with the Arenicolidæ. He was impressed by the occurrence of pigment-spots (eyes) on the head and along the body, and named the group accordingly. The digestive system of the Polyophthalmea presents a large buccal chamber, proboscis, a convoluted œsophagus, and a moniliform intestine, the whole being confined to the dorsal half of the cœlom by a muscular platform, beneath which are the reproductive elements. The circulatory system shows a heart of three chambers analogous to that in *Arenicola*. The respiration is probably cutaneous and rectal. He thought the secretory apparatus was represented by two "salivary" glands beneath and at the sides of the intestine anteriorly. The other structures were normal. The Opheliidæ were arranged according to the distribution of the branchiæ, *Ophelia* and *Travisia* having these only in the middle region of the body, whereas *Branchioscolex* had many branchiæ. The author does not mention *Armandia*, Filippi.

In the 'Schlesische Gesellschaft' for 1869 Grube reviews this family, and points out that the presence or absence of gills is an important feature. Thus:

(1) Without branchiæ—Ex. *Polyophthalmus*.

(2) With branchiæ or cirri in all the genera.

[1] 'Ann. Nat. Hist.,' ser. 4, vol. xvi, p. 369, with 2 text-figs.

[2] 'Dict. Sc. nat.,' t. 57, p. 479.

A. The branchia a simple filament, seldom papillose, very rarely forked.

a. Under this head he placed *Travisia*, which approaches the Scalibregmidæ.

b. The ventral surface flat, with a median groove.

b^1. Pharynx with two groups of papillæ. Body spindle-shaped; bristle-tufts double. *Terpsichore*, *Ladice*, etc. No British representative.

b^2. Pharynx without groups of papillæ; body elongated, with five ringed segments.

(1) Without cephalic or body-eyes, with double setigerous processes, and two anal cirri and papillæ. *Ophelia*.

(2) Eyes on the head and middle of the body; simple bristle-bundles. No anal cirri. *Armandia*.

(3) Without eyes, with simple bristle-bundles. *Ammotrypane*.

The same author (1878) adopts Œrsted's genus *Ophelina* instead of Malmgren's *Ammotrypane*, and points out that *Ophelia*, Savigny, has priority over both.[1]

Giard[2] (1880) published an interesting paper on the resemblances of the body-wall of *Polygordius* to that in the Opheliidæ, and thought that embryology might furnish further light on the relationships.

Cosmovici (1880) quotes Claparède as asserting that the segmental organs occur throughout the abdominal region in *Ophelia radiata*. He divides the segmental organs into two parts—(1) the glandular division, which he thinks is homologous with the organ of Bojanus in the mollusk; and (2) the segmental organ proper with its ciliated funnel. In his summary he states that in *Ophelia bicornis* there are five consecutive pairs of segmental organs with their proper apertures, and behind them other five segments, in each of which a pair of pouches of a sienna-colour occur, and which communicate only with the exterior.

The Syllidiformia of Levinsen[3] (1883) was a heterogeneous group, both as regards the *S. vera* and the *S. spionina*. With a point of interrogation, the sixth family of the latter was the Opheliidæ. It is difficult to understand what connection these have with the Spionidæ, Chætopteridæ, Cirratulidæ, Ariciidæ, or Chloræmidæ. He arranges the genera thus:—Tachytrypane, Ammotrypane, and Ophelia.

Carus (1885) placed this family between the Halelminthidæ and the Scalibregmidæ.

Kükenthal[4] (1886) gave an account of the structure of the nervous system of the family, specially dealing with the British species, *Travisia Forbesii* (which he included under it), *Ophelia limacina*, *Ammotrypane aulogaster*, and *Polyophthalmus pictus*. So far as observed, there is little that is striking in this system either in the cephalic ganglia or the nerve-cords, which do not usually present neural canals. He added, in 1887,[5] the following simple classification of the group: I. Opheliaceæ without a ventral groove—*Travisia*, Johnston. II. Ventral groove at the posterior part of the body—*Ophelia*, Savigny. III. Ventral groove extending throughout: A. without lateral eyes—*Ammotrypane;* B. with lateral eyes (1) with cirri—*Armandia*, Filippi; (2) without cirri—*Polyophthalmus*, De Quatrefages.

[1] See Grube, 'Jahresb. d. Schles. Gesellsch.,' 1868–9.

[2] 'Compt. Rend. Acad. Sc.,' Paris, Tome xci, 1880, p. 341.

[3] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 180.

[4] 'Jenaische Zeitschr.,' Bd. xx (N. F. xiii), p. 511, Taf. xxxii–xxxiv.

[5] 'Jenaische Zeitschr.,' Bd. xxi (N.F. xiv), p. 316, 1887.

Meyer[1] found three groups of ganglia in *Polyophthalmus pictus*—viz. anterior, middle, and posterior. Pruvot, again, in the ordinary Opheliidæ, described the posterior lobe as double—in connection with the nuchal organs. Kükenthal also states that there are three pairs of ganglia, but Racovitza[2] adversely criticises the views held by this author.

Ray Lankester[3] (1893) states that in *Ophelia* the vascular fluid contains a small number of corpuscles, amœboid in character, and which are impregnated with hæmoglobin from the surrounding fluid.

Benham's fifth sub-order of the Nereidiformia is the Scoleciformia, and it includes the Opheliidæ, Maldanidæ, Arenicolidæ, Scalibregmidæ, Chloræmidæ (his Chlorhæmidæ), and Sternaspidæ, a more or less doubtful association. The Polychæts do not lend themselves readily to such associations.

Schaeppi[4] (1897) carried out an investigation into the chloragogen of *Ophelia radiata*, his conclusions being that the lymph-cells take their origin in the peritoneum, and that the rod-cells and rods are genetically identical. The blood-system in the abdominal region consists of a dorsal vessel, the homologue of the gut-sinus, and a ventral trunk, and in the thoracic region of a dorsal vessel and a ventral, the homologue of the gut-sinus. The heart-body is not a glandular but a valvular structure. The alimentary epithelium contains chloragogen nuclei. The chloragogen of the peritoneum, the nephridia, and the connective-tissue of the sinuses contain guanin; that of the lymph-cells, the blood-cells, and those of the alimentary-canal he calls Chitinchloragogen. This author thought the rich folds of the stomach and gullet connected with alimentary respiration in *Ophelia*.

Philippson[5] (1899) reviews the relationships of this family with other families of Polychæta, and thinks they most nearly approach the Ariciidæ. He then considers the affinities of the various genera of the Opheliidæ amongst themselves. The most primitive condition, according to him, is found in *Armandia* and *Ammotrypane*. *Polyophthalmus*, again, is specialised for locomotion, whilst *Ophelia* and *Travisia* are adapted for a sedentary life. Lastly, he follows Racovitza in his interpretation of the nervous system of the group.

Bullot[6] (1904) performed experiments on the grey eggs of *Ophelia*, using KCL in the sea-water without fertilisation, and he found that the parthenogenetic larvæ arose from eggs which segmented regularly. In the case of fertilised eggs progress was more rapid, the proportion of larvæ was greater, and they survived longer. These experiments were suggested by cases in which eggs producing larvæ did not always segment.

Mr. Crossland notes in the Red Sea the close resemblance in form and movement of certain tropical Opheliidæ to *Amphioxus*, and they are abundantly dredged in the same localities.

The Opheliidæ generally frequent stretches of pure sand, though *Ammotrypane* is

[1] 'Arch. f. mikros. Anat.,' Bd. xxi, pp. 769–823, Pl. xxxii, xxxiii.
[2] 'Arch. Zool. expér.,' 3 sér., vol. iv, p. 166.
[3] 'Proc. Roy. Soc.,' No. 142, 1873.
[4] 'Jenaische Zeitschr.,' Bd. xxviii, p. 247, taf. 16–19.
[5] 'Zool. Anzeiger,' Bd. xxii, p. 417.
[6] 'Arch. f. Entwicklungsmechanik,' Bd. xviii, p. 161, 13 text-figs.

partial to soft grey mud, and the sluggish *Travisia* even frequents strongly odoriferous mud, as in the West Voe of Scalloway. The movements of *Ammotrypane*, *Polyophthalmus*, and *Armandia* are active, and some have likened those of *Ammotrypane* to the swift rushes of the lancelet.

Genus LXXX.—Ophelia, *Savigny*. Char. emend.

Head acuminate; sense-organs retractile. Mouth inferior. Body rounded anteriorly, posteriorly grooved ventrally. Caudal papillæ large. Dorsal and ventral fascicles of capillary bristles with a mamilla between. Ligulate branchiæ or dorsal cirri in all the following segments; the anus terminal, surrounded by papillæ. Corpuscles in blood (Claparède).

Ophelia was the eighth genus of Savigny's[1] Néréides (1820), and in his description he reversed the annelid, which was found by D'Orbigny on the shores of France, and the description leaves doubt as to its relationship with the common form.

Œrsted (1844) made this one of the genera of his *Ariciæ lumbricinæ* along with *Cirratulus*, *Dodecaceria*, *Ophelina*, and *Eumenia*, pointing out that the characters had hitherto been badly treated, the dorsal having been mistaken for the ventral surface, and the mouth for the anus. He defined the group as consisting of large, non-pellucid forms, without tentacles, with bifid feet and filiform, ligulate or subramose branchiæ.

Claparède[2] (1868) refers to the structure of the alimentary canal, and points out that Œrsted describes anteriorly a cæcum which he considers to be a salivary gland, and De Quatrefages a proboscis, whilst Delle Chiaje thought it was a respiratory vesicle, and G. Costa a fleshy heart comparable to the vertebrate organ. Claparède describes and figures the organ in *Ophelia radiata* as a double conical cæcum, the posterior extremity of which lies freely above the œsophagus, the anterior and larger end being fixed to the wall of the body. It forms a double muscular screen between the cephalic region and the perivisceral cavity, arresting the perivisceral corpuscles in their forward flow, and it may be, by its contraction, stiffening, like an injector, the pointed snout of the animal in its movements through the sand. An interesting feature in the circulation is the presence of numerous blind branches of the dorsal vessel in the cephalic region in front of the muscular cæcum.

1. Ophelia limacina, *H. Rathke*, 1843. Plate LXXXVIII, fig. 1; Plate XCV, figs. 1 and 1 *d*—head and tail; Plate CIII—bristle.

Specific Characters.—Head a pointed cone. Mouth opposite the first bristle-bundle. Body 2—2½ inches long, somewhat fusiform, more massive than in *Ammotrypane aulogaster*, enlarged in the anterior third, deeply grooved ventrally throughout the rest of its extent, the ventral longitudinal muscles forming prominent lateral ridges bearing the feet, which are about thirty-four in number; the first ten have the pale iridescent bristles supported by a fillet in front and behind, but at the eleventh the posterior fillet is dorsally much

[1] 'Syst. Annél.,' pp. 3, 12, 38.
[2] 'Annél. Nap.,' p. 289.

enlarged as a lamella behind the bristles, and from it the long tapering branchia (dorsal cirrus) extends, and is continued to the posterior end. Anterior segments 3-ringed, posterior with a single transverse furrow. Proboscis forming a button-shaped process in extrusion. Capillary bristles in two tufts, the dorsal considerably longer, but both curving outward and backward as long, simple, tapering, longitudinally striated, and brittle structures. Body diminishes abruptly posteriorly, and ends in a vent surrounded by about a dozen short cirri, two on the ventral surface being much larger, and in life of a deep red hue. Colour of a deep pinkish red (from the great vascularity), with purplish iridescence of the surface. The segmental organs occur throughout the whole of the "abdominal" region, and each has the form of a simple brownish tube with a ciliated internal tunnel, and an external opening near the bristles (Claparède), within which it is dilated.

Synonyms.

1820. *Ophelia bicornis,* Savigny. Syst. Annel., p. 38.
1825. *Lumbricus radiatus,* Delle Chiaje. Mem. degli Anim. II. pp. 414, 428, Tab. xxix, figs. 1—4.
1834. *Ophelia limacina,* Audouin and Edwards. Hist. nat. litt. France, Annel., p. 267, Pl. v^{B}, figs. 7—9.
1840. „ *bicornis,* Œrsted. Kroyer's Naturh. Tidsskr., Bd. iv, p. 126.
„ „ *mamillata,* idem. Ibid., p. 126.
1841. „ *bicornis,* Delle Chiaje. Descriz, vol. v, p. 99 ; pl. 100, figs. 1—6.
1843. „ „ Œrsted. Ann. Dors., pp. 52, 204, f. 104–5, 115, 116 and 121.
1843. *Ammotrypane limacina,* H. Rathke. Beitr. Fauna Norw. (Nova Acta Leop.-Car.), t. xx, p. 190, Tab. x, f. 4—8; Tab. xi, fig. 14.
1851. „ „ Grube. Fam. Annel., pp. 70 and 135.
„ *Ophelia bicornis,* Sars. Nyt Mag. f. Naturvid., vi, p. 207.
„ „ *mamillata,* idem. Ibid., p. 207.
1853. „ *limacina,* idem. Ibid., vii, p. 381.
1857. *Ammotrypane limacina,* Koren. Nyt Mag. f. Naturvid., ix, p. 94.
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 119.
1861. „ „ idem. Reise, 1857, Nyt. Mag. f. Naturvid., xi, p. 53.
1865. „ „ Johnston. Cat. Worms Brit. Mus., pp. 217 and 344, fig. 41.
„ „ „ De Quatrefages. Annel. II, p. 279.
„ „ *borealis,* idem. Ibid., p. 273.
1867. *Ophelia limacina,* Malmgren. Annul. Polych., p. 74.
1874. „ *borealis,* De Quatrefages. C. R. Assoc. Franç., 1873, p. 653.
„ „ *limacina,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 124.
„ „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 23.
1878. „ „ McIntosh. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 505.
1879. „ „ Tauber. Annul. Danica, p. 107.
„ „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. 16, p. 48.
1881. „ *acuminata,* Leslie and Herdman. Proc. Roy. Phys. Soc. Edinb., vol. xi, p. 275.
1883. „ *limacina,* Wirén. Chætop. Sibir. och Berings Haf, 'Vega' Exped., p. 406.
1884. „ „ Webster and Benedict. Rep. Comm. Fish and Fisheries U.S.A. for 1881, p. 724.
„ „ „ Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 119.
1885. „ *bicornis* (nervous syst.), Pruvot. Arch. Zool. expér., 2^{e} sér., t. ii, p. 308, pl. xv, figs. 1–2.
1886. „ *coarctata,* Harvey Gibson. Proc. Lit. and Philos. Soc. Liverp., vol. xl, p. 155.
1887. „ *limacina,* Kükenthal. Jenaische Zeitschr., Bd. xx, p. 532, Taf. xxxii, figs. 22–24.

1888. *Ophelia limacina,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 654.
1890. „ „ Malaquin. Annél. Boulon., p. 46.
1891. „ „ Hornell. Trans. Biol. Soc. L'pool., vol. v, p. 247.
1894. „ „ Bidenkap. Christ. Vid. Selsk. Forh., p. 103.
1896. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 332.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 136.
1898. „ „ Idem. Grönländ Annel., p. 127.
„ „ *bicornis,* De St. Joseph. Ann. Sc. nat. 8e sér., t. v, p. 380.
1907. „ *limacina,* Fauvel. Bull. Inst. Ocean., No. 107, p. 25.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. i, pp. 375 and 387.
1908. „ *Rathkei,* McIntosh. Ibid., p. 375 (young).
1910. „ *limacina,* Southern. Proc. Royal Irish Acad., vol. xxviii, p. 240.

Habitat.—Fine specimens are abundant after storms on the West Sands, and occasionally on the East Sands, St. Andrews, and it is also dredged on the sandy ground in the Bay. Not uncommon in the stomach of the haddock, often in company with green-pea urchins, ophiuroids, and sessile-eyed crustacea (E. McIntosh). Near low water on various parts of the Scottish shores. Forth (Cunningham and Ramage). Firth of Forth (Leslie and Herdman). Killiney Bay, Co. Dublin (Southern).

Abroad it extends to Greenland (Œrsted, Michaelsen, etc.), Spitzbergen (Fauvel, etc.), Iceland and Norway (H. Rathke, Malmgren, and A. M. Norman), generally on muddy or sandy ground.

In all probability the same or a closely allied form frequents the Atlantic Coast of the United States of America (Verrill, Webster, and Benedict). Northern Seas (Wirén).

Head (Plate XCV, figs. 1 and 1 *a*) forming an acute cone which may be useful in boring, as it is rendered tense by the waves of the perivisceral fluid, which also sometimes cause the proboscis to protrude as a pink frilled mass marked by fine grooves. The strong muscles of the region behind also probably aid in stiffening the pointed snout. Though no nuchal organs have been seen in the living forms tossed on the beach, they may occur under more favourable circumstances.

Body 2 to $2\frac{1}{4}$ in. in length, somewhat fusiform, the widest part being usually about the anterior third or fourth; rounded dorsally, but deeply grooved on the ventral surface, the powerful ventral longitudinal muscles forming a prominent ridge at each side. The body diminishes abruptly posteriorly, and ends in a vent surrounded by about a dozen short cirri, two much larger being ventral, and occupying a similar position to those in *Ammotrypane aulogaster* (Plate XCV, figs. 1 *b* to 1 *d*). The dorsal processes are figured by Rathke as much fewer and shorter than in the well-developed forms from St. Andrews. The surface is finely annulated, a feature due to the transverse linear thickenings of the skin, a double line indeed being seen under the microscope, and occasionally the line is forked. The alimentary-canal is usually filled with sand.

Colour when fresh of a deep pinkish red, with iridescence of the surface, which sometimes, especially in confinement, shows a pale lilac or bluish tint. The colour, however, alters after a brief confinement, and the general hue on the second day is a greyish pink with a tinge of lilac. The two short and somewhat thick ventral cirri below the anus remain of a bright red after the rest of the body has become pale. The cutaneous

ridges are pale. The colour appears to be due to the bright reddish hue of the blood. Occasionally a large example is iridescent bluish.

When the proboscis is ejected it forms a button-shaped process (Plate XCV, fig. 1 *a*) of a reddish hue, with a slightly frilled margin and hollow centre, this part being differentiated from the conical glistening basal part (*a*) of the aspect of the ordinary skin. When the proboscis is withdrawn it forms a long conical muscular organ lying over the alimentary-canal, the base of the cone being at the mouth, the apex posterior. The gullet is succeeded by a large muscular crop or proventriculus, with dark pigment posteriorly at the constriction between it and the next region, and this is followed, after a slight contraction, by a dark stomach, behind which is the intestine filled with sand.

The ventral longitudinal muscles are proportionately more massive than in *Ammotrypane*, but they do not extend so far forward, about a fourth of the anterior region—which is generally more or less dilated—being devoid of them. The ventral nerve-cord is pinkish.

Along each side of the body is a row of more or less sessile feet. The first is represented by a double tuft of fine bristles, which curve backward at a point exactly opposite the mouth, and thirty-four occur behind it, those near the tail sending their long bristles backward like a fringe. The fine cutaneous ridge is interrupted in front of the first foot, and a separate fillet marks the foot anteriorly. Each bristle-tuft then arises from a small papilla behind it. Three entire cuticular ridges occur between this and the second foot, which shows the fillet in front and the two convex processes or papillæ behind for the bristles, which are pale golden. In the third foot the fillet anteriorly is bilobed, and the bristle-papillæ somewhat more prominent. Little change occurs till the eleventh foot, except that the anterior fillet soon forms a guard to the bristles in front, and a fillet lies behind, so that the bristles emerge between them. At the eleventh foot the posterior fillet dorsally is much larger, forming a lamella behind the bristles, and from it a long tapering dorsal cirrus extends, and the cirri are continued on each foot to the posterior end of the animal.

The segments are marked by a more prominent lateral ridge passing to the edge of the foot, three or four others lying in the flattened pit between them and above the ventral prominence of the longitudinal muscle of the side.

The dorsal bristles (Plate CIII, fig. 1) are simple and curved, taper to a delicate point, and are marked by fine longitudinal lines. They are considerably longer than those in the ventral tuft, but both have the same curvature (outward and backward), structure, and pale golden colour, and both are somewhat brittle.

The dorsal cirri or branchiæ are of a pale red, and, though of a different shade from the rest of the body, are not conspicuous. The example was perhaps imperfectly preserved, but it did not show the transverse vessels of the organ seen in *Ammotrypane*. Cilia are probably present as in *O. radiata*.

In the present species a large blood-vessel on the dorsum is formed by the union of the trunks from the intestinal region, and it goes forward to the anterior part of the stomach, where it is joined by two large vessels from the ventral which run obliquely into it. Passing straight forward, it breaks up into three trunks anteriorly.

Habits.—The only motions exhibited by the animal in confinement are slight elongations and contractions, or curvatures caused by irritating it with a needle. At intervals also the snout in front and behind the mouth is thrown into four longitudinal grooves and ridges by contraction, both dorsally and ventrally. These do not affect the smooth terminal cone and its slender papilla at the tip. Occasionally these contractions of the snout would, from their regularity, appear to perform a special function—probably connected with the driving forward of the tip in boring. On the whole it appears to be sluggish, though its powerful ventral muscles must fit it for a considerable amount of motion amongst the sand. When dislodged from the sand and tossed on the beach no effort is made to bore, probably from exhaustion. Yet they live in sea-water in confinement for weeks, although the pink hue of the two terminal ventral cirri soon disappears.

Reproduction.—On January 2nd the perivisceral space was crowded with small ova —somewhat ovoid in outline. The males of *Ophelia radiata*, D. Ch., are distinguished by their whitish colour, the females being greenish from the tint of the ova (Claparède). The spawning period of this species is from October to July (Lo Bianco).

A small example (Plate XCV, figs. 2 and 2*a*) about half an inch in length, dredged in Valentia Harbour by Dr. Gwyn Jeffreys, in May, 1870, and which had well-developed ova in the cœlom, differed so much posteriorly from the ordinary examples, that it was thought to be specifically distinct. Further examination, however, shows that it is a young stage of *O. limacina*. The head (Plate XCV, fig. 2) and the general shape of the body agree with the latter, but the segments are less numerous (twenty-two or twenty-three). The cirri commence in both on the same foot (eleventh), but the organs are shorter and do not quite reach the tail. Moreover the latter differs in structure from the ordinary form, for the tip of the tail (Plate XCV, fig. 2*a*) presents only a few blunt papillæ dorsally, and a rounded median, and two short lateral papillæ ventrally. When viewed from the end this region shows a series of short, blunt papillæ, about nine in number, in the form of an arch over the large central and bluntly rounded papilla on the ventral surface. One of the papillæ forming the arch had a terminal sharp process or papilla distally, but it is uncertain whether the others had such. It would, therefore, appear that a considerable change takes place during the growth of this species in the aspect of the caudal region, the two ventral processes, as the adult stage is reached, assuming an elongated conical form with a probe-point, whilst the small papillæ in the young above these have now developed into conspicuous cirri.

The *Lumbricus radiatus* of Delle Chiaje[1] (1825) indicates a form allied to *Ophelia limacina*, but the want of accurate definition in the drawings leaves room for uncertainty.

Milne Edwards (1834) inverted the animal, placing the head posteriorly with the mouth as the vent.

Audouin and Milne Edwards[2] thought that the *Nais Horatii* of Delle Chiaje[3] might be an *Ophelia*, but there is dubiety on this head, both in description and figures.

So far as Œrsted (1840) shows in his preliminary publication, *Ophelia bicornis* of

[1] 'Memorie degli Anim.,' vol. ii, p. 414. Tav. xxix, fig. 1.

[2] 'Annél.,' p. 267.

[3] 'Memorie,' vol. ii, pp. 405 and 427, Tab. xxviii, figs. 20 and 21.

Savigny and his *Ophelia mamillata* would appear to present few differences—other than the more numerous rings of the segments and a few more anal papillæ in the former. In his 'Annulata Danica Conspectus'[1] *O. mamillata* is also entered.

H. Rathke[2] (1843) found in this species a pore between the dorsal and ventral setigerous processes through which he thought the ova escaped from the body-cavity. A second and larger opening in proximity, was considered to be that of his blind sac (segmental organ). He thought that the cirri were branchial organs.

Dr. Johnston (1865) included this species under his second division—Limivora, family Opheliaceæ, and genus *Ammotrypane*. His descriptions and figures are good.

De Quatrefages (1865) appeared to be uncertain about the position of this form, which he placed at the end of the Opheliidæ.

Cosmovici[3] (1880) describes in *Ophelia radiata* the separation of the five pairs of segmental organs from his five pairs of organs of Bojanus, which are anterior, as quite complete, but his figure shows that the anterior organs (his organs of Bojanus) occupy the same relative positions as the posterior and probably represent less developed structures, and they have both internal and external apertures. The five pairs of segmental organs with which are associated the reproductive organs—male or female—follow, and have the same flask-shaped outline and, he says, serve for the transmission of the sexual products. This author observed the deposition of the ova, the animals first enveloping themselves in a glairy mucus in which the eggs are placed, and from which the annelid by-and-by withdraws, leaving a rounded mass with a long tubular process. The eggs are probably fertilised during deposition, and he watched the development. After extrusion from the egg the young Opheliæ present an elongated and somewhat spindled-shaped form with two eyes, and groups often attach themselves in a radiate manner to mucus or *débris* by the tail, and further, by-and-by, secrete a transparent capsule of mucus. During development two caudal papillæ appear, and the body at this stage has more than a dozen segments with a conical snout, alimentary apparatus, and anus.

Kükenthal[4] (1887) figures in *Ophelia limacina* a structure in a corresponding position to the sense-organ in *Scalibregma*, and Rathke[5] described small apertures similarly situated in the same species. They probably are sense-organs, though Rathke thought them ovipores.

Awerinzew[6] (1908) describes a parasitic Infusorian somewhat like an *Opalina* and which he terms *Butschliella opheliæ* in the intestine of this species from Barent's Sea.

[1] p. 45.
[2] 'Fauna Norweg.,' p. 208, Tab. xi, fig. 14.
[3] 'Org. Segment. Annél.,' p. 62.
[4] 'Jenaische Zeitschr.,' Bd. xx, p. 510, Taf. xxiii, fig. 94.
[5] 'Beitrage,' Taf. x, fig. 15, p. 203, and Taf. xi, fig. 14.
[6] 'Zeitschr. f. wiss. Zool.,' Bd. xc, p. 334, Taf. xix.

Genus LXXXI. AMMOTRYPANE,[1] *H. Rathke*, 1843.

Head terminating in an acute cone anteriorly, devoid of tentacles and eyes, but it may have nuchal organs. Body elongate, more or less fusiform, muscular, elastic, iridescent and ringed, terminating posteriorly in a scoop or in cirriform processes; forty-eight or more segments. Mouth on the ventral surface as a transverse slit, from which the proboscis is extruded. Ventral longitudinal muscles prominent. Ventral cirrus present or absent. Terminal pair of cirri enlarged and rather short. Feet slightly developed, simple or biramous, the dorsal cirrus being enlarged into a branchia, the setigerous region being sessile, the bristles simple, long, pale golden, tapering and curved, with fine longitudinal lines.

A notable contribution was made to this group by H. Rathke,[2] who instituted the genus Ammotrypane, with the species *A. aulogaster*, *A. limacina*, and *A. œstoides*. He gave a good description of their external appearance and of their internal structure, with original figures.

1. AMMOTRYPANE AULOGASTER, *H. Rathke*, 1843. Plate XCV, figs. 3–3*d*—head, body, tail and foot; Plate CIII, figs. 3 and 3 *a*—bristles.

Specific characters.—Head acutely pointed, with a stalked mucro in front, and posterior nuchal organs. Body $2\frac{1}{2}$ ins. long, much elongated, fusiform, rounded dorsally, deeply grooved from end to end ventrally; feet simple, a single tuft of simple bristles, a large ligulate dorsal cirrus (branchia), and a small ventral cirrus. Segments 55—60. Anus terminating in a scoop-shaped hood opening ventrally, and with four cirri along each border posteriorly, a pair of larger and rather thick cirri being at its base with a more slender median cirrus between them.

SYNONYMS.

1843. *Ammotrypane*[1] *aulogaster*, H. Rathke. Beitr. Fauna Norw., Nova Acta Leop.-Car., t. xx, p. 188, Tab. x, f. 1—3, Tab. xi, f. 15.
1843. *Ophelina acuminata*, Œrsted. Annul. Dan. Consp., p. 45.
1844. „ „ idem. Arch. f. Naturges., Bd. x, p. 111, Tab. iii, figs. 24—26.
„ „ „ idem. Region. Mar., p. 78.
1845. *Ophelina aulogaster*, Kröyer. Nat. Tidsskr., 2 ser, i, p. 414.
1851. *Ophelia acuminata*, Grube. Fam. Annel., p. 70.
„ „ *aulogaster*, idem. Ibid., pp. 70 and 135.
1853. *Ammotrypane aulogaster*, Sars. Nyt Mag. f. Naturvid., vii, p. 391.
1857. *Ophelia aulogaster*, Koren. Ibid., ix, p. 94.
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 119.
1861. „ „ idem. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 53.

[1] Αμμος and τρυπάνη, sand-borer.
[2] 'Fauna Norwegens,' pp. 186–208, Tab. x.

1864. *Ophelia aulogaster,* Kölliker. Kurzer Bericht (Würzburger naturwissensch. Zeitschr.), v Bd., p. 10.
1865. ,, *acuminata,* Johnston. Cat. Worms Brit. Mus., p. 215 and 144, figs. 39 and 40.
,, *Ophelina aulogaster,* Œrsted. Dröbak, p. 17 (*fide* Malmgren).
,, *Ophelia acuminata,* De Quatrefages. Annel., ii, p. 278.
1867. *Ammotrypane aulogaster,* Wirén. Kongl. svenska Vet. Akad. Handl., Bd. 22, text., and Taf. ii, fig.6; Taf. iii, fig. 3, figs. 8—11; Taf. iv, figs. 8 and 9; Taf. v, figs. 9 and 14.
,, ,, ,, Malmgren. Annul. Polych., p. 73.
1868. ,, ,, Sars. Christ. Vid.-Selsk. Forhandl., p. 10 (sep. copy).
1873. ,, ,. Idem. Nyt Mag. f. Naturvid., xix, p. 242.
1874. ,, ,, McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 200.
1875. ,, ,, Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 23.
,, ,, ,, McIntosh. Invert. and Fishes St. Andrews, p. 124.
1878. ,, ,, Idem. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 504.
1879. ,, ,, Tauber. Annul. Danica, p. 107.
,, ,, ,, Théel. Kongl. svenska Vet. Akad. Handl., Bd. 16, p. 48.
1881. ,, ,, Leslie and Herdman, Proc. Roy. Phys. Soc. Edin., vol. vi, p. 66.
1883. ,, ,, Wirén. Chætop. "Vega" Exped., p. 406.
1884. ,, ,, Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 119.
1886. ,, ,, Levinsen. Kara-Havets, p. 9.
,, ,, ,, Wirén. Kongl. svenska Vet. Akad. Handl., pls. i–v.
1887. ,, ,, Kükenthal. Jenaische Zeitschr., Bd. xx, p. 534.
1888. ,, ,, Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 654, pl. xlii, fig. 15 *d*.
1889. ,, ,, Kükenthal. Arch. f. Naturges., vol. lv. p. 148.
1891. ,, ,, Hornell. Trans. Biol. Soc. L'pool., vol. v, p. 247.
1897. *Ophelina acuminatia,* Michaelsen. Polych. deutsch. Meere, p. 134.
1894. *Ammotrypane aulogaster,* Bidenkap. Christ. Vid. Selsk. Forhandl., No. 10, p. 102.
1896. ,, ,, Benham. Camb. Nat. Hist., vol. ii, p. 331.
1904. ,, ,, Journ. M. B. A., vol. vii, p. 230.
1907. ,, ,, Fauvel. Bull. Inst. Ocean., No. 107, p. 26.
1908. ,, ,, McIntosh. Ann. Nat. Hist., ser. 4, vol. i, pp. 375, 385, and 387.
,, ,, ,, Moore. Proc. Acad. Nat. Sc. Philad., p. 354.

Habitat.—Dredged in three fathoms in the laminarian region on a bottom of pure sand, Lochmaddy, and also on a bottom of tenacious grey mud, in company with *Lumbriconereis* in Ardmaddy Bay, North Uist. Amongst tangle-roots in mud at nine fathoms in the West Voe of Scalloway (W. C. M.). Nine miles off Bulta, Shetland, in sixty fathoms (J. G. J.). At various parts of the coast, both eastern and western of both England and Scotland. Cullercoats (J. Alder). Firth of Forth (Lieut. Thomas, Cunningham and Ramage). 'Porcupine,' 1869. Firth of Clyde (D. Robertson). Nymph Bank and other parts, south-west Ireland, 1886 (R. I. A.).

Common in northern regions, such as the North Sea, Norway (Rathke), Spitzbergen, Greenland, Iceland, and Scandinavia (Malmgren). The largest example comes from Finmark (Canon Norman). Probably found in America (Verrill). Kara-Havets (Levinsen). N. Pacific Coast of N. America (Moore).

Head (Plate XCV, fig. 3 *a*), conical, pointed anteriorly and terminated by a stalked mucro. It is rounded dorsally, slightly flattened ventrally, the rounded lateral muscular ridges ceasing before the tip is reached.

Body (Plate XCV, fig. 3), 1—3 in., elongated, fusiform, smooth to the naked eye, but showing transverse striæ under a lens. It is tapered about equally at each end, the anal process, however, giving a somewhat more pointed condition posteriorly. The dorsum is convex and marked by faint segment-lines, the ventral surface is grooved or flattened, the lateral muscular ridges bearing the feet, which, in a large example, are fifty in number. Posteriorly the ridges terminate at the base of the scoop-shaped tail in two somewhat clavate cirri.

The entire animal has a fine, bluish, pearly iridescence. It is dusky yellow on the dorsum with brown touches, from the intestine: or pale anteriorly, then brownish; with the intestinal region greyish. The tail is pale or tipped with red. The under surface is of a pale flesh-colour, and with a pearly iridescent lustre throughout. The dorsal cirri have a red central streak.

The foot (Plate XCV, fig. 3 *d*) consists of a long dorsal cirrus, somewhat constricted at its base—which is at the upper border of the prominent muscular fillet at the ventral region—then enlarges, and again tapers to the extremity. Its length at the anterior third is fully the vertical diameter of the body, but it diminishes anteriorly and posteriorly, and it is somewhat flattened. The transverse vessels give a barred appearance to the organ as a transparent object. Immediately beneath is a combined setigerous process and a short ventral cirrus. The bristle-tuft is very slender, consisting of long, slender, simple hairs (Plate CIII, figs. 3 and 3 *a*), tapering to a delicate point, and with fine longitudinal lines. A longer and a shorter series of bristles would seem to indicate that the tuft is double, as Dr. Johnston mentioned. The slender iridescent hairs emerge close to and somewhat beneath the anterior base of the branchial process (dorsal cirrus), and are directed, as a rule outward and backward. The short ventral cirrus is disproportionately small.

The great ventral muscular bands pass backward—diminishing toward the tail—until they cease (as external objects) at the base of the two rather thick cirri, which are slightly fusiform and with blunt tips. These cirri arise close together, and mark the commencement of the caudal process or scoop, the hollow of which is ventral and the convexity dorsal, the posterior end forming a pointed and hollow cone. The inner border of the ventral edge has a series of well-marked papillæ or short cirri (Plate XCV, figs. 3 *b* and 3 *c*), for in well-preserved examples from St. Magnus Bay (100 fathoms), this process has a long median cirrus above the ventral pair, the arch of the hood has regular transverse striæ, and the tip, which curves downward, terminates in a small median cirrus, whilst the edges are fringed. This delicate apparatus is frequently imperfect. Fauvel has also noted the occurrence of this unpaired cirrus. The apparatus evidently has special functions in life, and differs from those in which the anal scoop has its concavity directed dorsally. It is possible that the abbreviated condition of the body and its habits in the sand necessitate a different mode of ejecting the effete matter.

Habits.—The extraordinary activity and vigour of the living animals at once attract attention. They exceed most annelids in the display of violent muscular action, as they

rush about in every direction through water or sand, mucus or mud, and then generally plunge into sand. It has never been encountered at low water, so that its home would appear to be the laminarian region and deeper water.

Dr. G. Johnston (1865) mentioned the occurrence of black specks behind the snout in some specimens, but he was uncertain whether they were eyes. Such have not been observed.

Ammotrypane gracile, procured by the 'Challenger'[1] near Japan, is a closely allied form.

Wirén (1887) included this species in his careful account of the anatomy of the limivorous polychæts. He gives a figure of a transverse section through the middle of the body which, however, has the ventral longitudinal muscles as simple rounded bands.

Cunningham and Ramage (1888) point out that the first setigerous segment bears no branchia, that the spear-shaped anal extremity has cirri round its posterior edge, and a long cirrus between the two small fusiform appendages in front of the vent. They figure a species of *Opalina* from the intestine.

2. Ammotrypane cylindricaudatus *Hansen*, 1879. Plate XCV, figs. 4 and 4 *a*—body and tail; Plate CIII, figs. 14 and 14 *a*.

Specific Characters.—Head an acute cone, ending in a slender process with a clavate tip. Ventral longitudinal muscles pass forward almost to the extremity of the snout. Mouth a short distance behind the latter. Body very slender, with numerous branchial cirri, which are specially conspicuous posteriorly, as also are four setigerous processes in front of the caudal appendix—which is cylindrical or somewhat clavate, transversely marked by minute ribs or grooves, and with an uneven posterior margin. Bristles short, simple, and tapering.

Synonyms.

1879.	*Ammotrypane cylindricaudatus*,	Hansen.	Nyt Mag. f. Naturvid., Bd. xxiv, p. 4, Taf. vi, f. 1—8.
1882.	„	„	idem. Norske Nord. Exped., vii, p. 36, Tab. vi, figs. 20—28.
1883.	„	„	Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 118.
1883.	„	*cylindricaudata*,	Wirén. Chætop "Vega" Exped., p. 406.
1886.	„	*cylindricaudatus*,	Levinsen. Kara-Havets, p. 9.
1894.	„	„	Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 101.
1897.	„	„	Michælsen. Polych. deutsch. Meere, p. 134.
1908.	„	„	McIntosh. Ann. Nat. Hist., ser. 8, vol. i, pp. 384, 385, and 387.
1909.	„	„	Fauvel. Bull. Inst. Ocean., 142, p. 8.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870, at 740 fathoms, at Station No. 17 *a*. 32° 31′ N. Lat. and 9° 39 W. Longit. Bottom temperature, 49·3°.

St. Lawrence, Canada, 1872 (Whiteaves).

Norway, various stations, Dr. Merle Norman in 1879. Siberian Seas and Behring's Sea. Kara-Havets (Levinsen). Spitzbergen (Fauvel). N. Atlantic (Hansen). Finmark (A. M. Norman), large.

Head (Plate XCV, fig. 4) forming an acute cone terminated by a slender process

[1] 'Report on the Annelida,' p. 357, pl. xlii, figs. 9—12, 1885.

with a clavate tip. The great ventral longitudinal muscles taper toward the snout and appear to run forward almost to the tip. The mouth opens a short distance behind the anterior end. Nuchal grooves on each side of the snout.

Body (Plate XCV, fig. 4) characterised by its length and slenderness, and the presence of numerous branchial cirri along the sides, by their conspicuous condition posteriorly, and the presence of four lateral setigerous processes at the base of the caudal appendix. The latter forms a cylinder of considerable length, minutely ribbed transversely, and with an uneven margin posteriorly, that is to say, the dorsal edge forms a prominent papilla, the ventral being less prominent, whilst an elevation occurs between them. In the majority the process is gradually narrowed to its base, so that it is really somewhat clavate. The form of the tip, however, varies in the different examples, probably from friction or other injury. The caudal process has a considerable dorsal curvature, and apparently is readily reproduced after removal. The bristles are comparatively short, simple, curved, and tapering (Plate XCV, fig. 4 *a*), and seem to present no peculiarity.

This differs from the *Ammotrypane Ingebrigtsenii*, Kükenthal,[1] from Spitzbergen, to which it is somewhat allied, by the greater number of segments in the latter, which has also dorsal and ventral cirri, an anal region with two longer ventral cirri, and on each side of the group are five small papillæ. Four rings occur between each foot.

This species was first described and figured by Hansen from the Norwegian Northern Expedition of 1876. Though somewhat indistinct his figures are recognisable.

The *Ammotrypane lævis* of Percy Moore[2] (1906) from Alaska appears to be a closely allied form.

Genus LXXXII.—Armandiella, *n.g.*

Head obtusely rounded anteriorly and devoid of eyes, the ventral longitudinal muscles running forward almost to the anterior border. Minute nuchal organs in front of the lateral groove. Body as in the family, but not divided into distinct segments, with lateral cirri, and, at the base, two setigerous tubercles.

1. Armandiella Robertianæ, *McIntosh*, 1908. Plate XCV, fig. 5—entire animal; Plate CII, fig. 15.

Specific Characters.—Head forming an obtuse, rounded anterior border without eyes, the ventral longitudinal muscles running forward almost to the tip and thus differing from those of *Ammotrypane* and *Ophelia*. Minute nuchal organs in front of the lateral groove. Body 14 mm. long, somewhat short and thick, slightly tapered anteriorly, rounded dorsally and grooved ventrally, the powerful ventral longitudinal muscles forming a conspicuous ridge on each side almost from end to end. Posteriorly an abrupt diminution occurs at the caudal process, which is directed upward, the free end of the funnel

[1] 'Arch. f. Naturges.,' 55, p. 147, 1889.

[2] 'Proc. Acad. Nat. Sc. Philad.,' July, 1906, p. 354, Text-fig.

being bevelled from below upward and forward, and furnished with short and somewhat clavate cirri, the most conspicuous being the larger ventral pair. Bristles inconspicuous anteriorly, visible under the microscope at the commencement of the posterior third, evident and long at the caudal process, simple, tapering, and curved. Colour of the dorsum greenish with dark brownish specks, a dark central transverse bar occurs at intervals, and a row of dark specks (eyes) also at intervals in the groove above each ventral longitudinal muscle. Under surface pale greenish.

Synonym.

1908. *Armandia Robertianæ,* McIntosh. Ann. Nat. Hist., ser. 8, vol. i, p. 376.

Habitat.—Dredged amongst sandy mud in six or seven fathoms off one of the small islets in the sound of Harris, August, 1872.

Head (Plate XCV, fig. 5) forming a somewhat obtuse rounded cone, marked dorsally by a constriction, whilst ventrally the prominent ridges of the ventral longitudinal muscles leave only a small rim at the snout free. Minute nuchal organs are present on each side just in front of the termination of the lateral groove, but they are only distinct in life.

Body (Plate XCV, fig. 5) about 14 mm. in length, somewhat short and thick, tapered at each end, rounded dorsally and grooved ventrally, the powerful ventral longitudinal muscles forming a conspicuous ridge on each side—almost from end to end. The mouth opens as a small pit behind the isthmus of the great longitudinal muscles at the tip of the snout. The colour of the dorsum is greenish, speckled with dark brownish points, a dark central transverse bar occurring at intervals, so as to give the dorsum a segmented appearance. Much of this pigment remains in the spirit-preparation. The ventral surface is pale greenish.

The posterior end is abruptly diminished to an upturned caudal process, which is terminated by a slightly oblique border (the slope trending from below upward and forward) furnished with short and somewhat clavate cirri, two being dorsal and two ventral, besides two or three lateral, the most conspicuous pair being the ventral. These form a fringe to the anal aperture which thus opens into a small funnel. The diminished caudal region is marked by closely arranged circular striæ. The course of the great ventral longitudinal muscles differs from that of certain species, since they stretch from end to end, forming two prominent lateral ridges from the anterior border to the base of the diminished caudal region, and being lost on the upturned narrow process. In the groove above each ventral ridge is a series of dark brown pigment-spots (eyes) at regular intervals, but no bristles are visible except in the posterior region, where five to seven tufts of slender, curved, glistening bristles form a fringe on each side—sloping downward and backward. Moreover, upon the narrow caudal process a few occur on the sides distally, but their origin is uncertain. These bristles (Plate CIII, fig. 15) are translucent, taper to a fine point and do not show evident striations. Small tufts of these occur considerably in front of those just mentioned, but are only visible under the microscope. Whether in the living form these bristles go further forward is unknown.

Reproduction.—The period of reproductive activity of an allied form (*A. polyophthalma*) according to Lo Bianco (1909) is from April to July.

Habits.—Like its congeners this species is an active inhabitant of muddy sand, and it swims through the water swiftly, like an eel.

The *Armandia Dollfusi* of De St. Joseph[1] has a long filiform process (tentacle, De St. Joseph) at the tip of the snout, and the anal funnel also differs, though both have two longer ventral cirri, and the dorsal slit of the caudal region is carried forward. It also appears to differ from Kükenthal's *A. polyophthalma*, as described by him and Lo Bianco, in the anal funnel and other parts.

This form likewise differs from *Armandia intermedia*, Fauvel,[2] in having no long unpaired cirrus between the longer ventral pair of cirri.

Genus LXXXIII.—Polyophthalmus, *De Quatrefages*, 1850.

Head short, rounded, with a vertical fissure on each side for the protrusible nuchal organ, infundibulariform in outline, and with a folded margin. Buccal segment with bristles. Exsertile pharynx patelliform. Body smooth, ventral region separated from the lateral by a groove, the middle region having ventro-lateral eyes with a single crystalline body, slightly diminished posteriorly, and ending in an anus with cirri. No branchiæ. Minute capillary bristles ventro-lateral in position.

Mario Lessona[3] in 1883 gave the anatomy of *Polyophthalmus*.

The close relationship of *Polyophthalmus* with the Opheliidæ was pointed out both by Filippi[4] and Grube.[5]

1. Polyophthalmus pictus, *Dujardin*, 1839. Plate LXXXVIII, fig. 2; Plate C, fig. 11—foot and bristles.

Specific Characters.—Head bluntly rounded, with well-marked nuchal organs, and occasionally a pigment-speck on each side in front of the nuchal brown band. Body about an inch in length, elongated, somewhat fusiform, rounded dorsally, and grooved ventrally, the ventral longitudinal muscles being prominent. Segments, about thirty, biannulate. Posteriorly it tapers to the abruptly diminished caudal process, which forms a short cone with a few short terminal cirri. Dorsum marked by about thirty transverse bars of brown, with a fine dusting of the same pigment between and beyond them. Along the lateral groove is a single series of pigment-spots symmetrically arranged. Some of Claparède's examples were brownish green.

Synonyms.

1839. *Nais picta*, Dujardin. Ann. Sc. nat., 2e sér., t. xi, p. 293, pl. vii, figs. 9—12.
1850. *Polyophthalmus pictus*, De Quatrefages. Ann. Sc. nat., 3e sér., t. xiii, p. 11, pl. ii, figs. 1—15.

[1] 'Ann. Sc. nat.,' 7e sér., xvii, p. 114, pl. vi, figs. 148—151.
[2] 'Bull. Soc. Linn. Normandie,' 5e sér., 5e vol., p. 86, text-figs. 29 and 30, 1902.
[3] 'Mem. Accad. Torino,' ser. 2, t. xxxv, 1883.
[4] 'Archivio per la Zoologia, l'Anatomia,' etc., Genova, 1861, p. 315.
[5] 'Ausflug nach Triest,' etc., p. 49; and 'Arch. f. Naturg.,' xxix, 1865, p. 49.

1861. *Polyophthalmus pictus*, Grube. Ausflug nach Triest, etc., p. 49.
1864. ,, ,, Claparède. Glanures, p. 5, pl. i, f. 1 and 2.
,, ,, ,, Grube. Insel Lussin, p. 85.
1865. ,, ,, De Quatrefages. Annel., ii, p. 205.
1878. ,, ,, Grube. Annul. Semper., p. 196.
1880. ,, ,, Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 100.
1881. ,, ,, Idem. Nova. Acta. Leop.-Car., Bd. xlii, 3, p. 116.
1882. ,, ,, Meyer. Arch. f. mikros. Anat., xxxi, p. 769, Taf. xxxii and xxxiii.
1884. ,, ,, Lessona. Mem. Accad. Torino, 2 ser., t. xxxv, p. 309, 1 pl.
1885. ,, ,, Carus. Fauna Medit., p. 250.
1887. ,, ,, Kükenthal. Jeñaische Zeitschr., t. xx, p. 547, pl. xxxiv, f. 39—42.
1891. ,, ,, Cuénot. Arch. Zool. expér., 2e sér., t. ix, p. 442, pl. xvii, f. 8.
1893. ,, ,, Lo Bianco. Atti Accad. Sc. Nap., 2e sér., t. v, No. 11, p. 8.
1896. ,, ,, Monticelli. Boll. Soc. Nat. Nap.. t. x, p. 35, pl. i.
,, ,, ,, Benham. Camb. Nat. Hist., vol. ii, p. 332.
1898. ,, ,, De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 385.
1904. ,, ,, Journ. M. B. A., vol. vii, p. 230.
1906. ,, ,, De St. Joseph. Ann. Sc. nat., 9e sér., t. iii. p. 232.
,, ,, ,, Gravier. Nouv. Arch. Mus. Paris, 4 sér., t. viii, p. 177.
1907. ,, ,, Fauvel. Bull. Inst. Ocean., No. 107, p. 27.
1908. ,, ,, McIntosh. Ann. Nat. Hist., ser. 8, vol. i, p. 377.
1909. ,, ,, Fauvel. Bull. Inst. Ocean., No. 142, p. 8.
1910. ,, ,, Elwes. Journ. M. B. A., vol. ix, p. 64.
1911. ,, ,, Fauvel. Bull. Inst. Ocean., No. 194, p. 27.
1913. ,, ,, Ehlers. Deutsch. Südpol. Exped., p. 526.

Habitat.—Connemara; Coast of Kerry (A. G. Moore); Bantry Bay (R. I. Acad.). Killeany Bay, two fathoms (Prof. Haddon); Killybegs Harbour, Ireland, 'Porcupine,' 1869; Roundstone Bay, Ireland, R. I. A., 1870; Galway, Valentia Harbour (J. G. Jeffreys), 1870. Plymouth (Allen). Common on the West Coat of Ireland from Valentia Harbour to Lough Swilley (Southern). Torquay (Elwes).

Antarctic Seas (Ehlers). Madeira and Canaries (Langerhans). Shores of France (Claparède, De St. Joseph) amongst corallines and algæ. Monaco (Fauvel). In a sponge at Saint Raphael (De St. Joseph). Mediterranean (Delle Chiaje, Panceri, Lo Bianco). Red Sea (Gravier).

Head (Pl. LXXXVIII, fig. 2) bluntly rounded and in the preparations devoid of eyes, but with well-marked nuchal organs, which occasionally project as papillæ on each side, though in life they are almost foliate and richly ciliated (De Quatrefages). In some of the preparations it is paler than the succeeding region, and shows a pigment-speck (eye) on each side—in front of the brown band at the neck. Protrusible nuchal organs are stated by Claparède to be present, and he mentions a median (over the brain) and two lateral eyes, as, indeed, De Quatrefages[1] had long before described and figured.

In general aspect this form resembles the Opheliidæ in the iridescent skin, elongated fusiform outline, the arrangement of the ventral longitudinal muscles which reach the

[1] "Études, Mém. sur la Fam. des Polyophthalmiens," 'Ann. Sc. nat.,' 3e sér., t. xiii, p. 11, pl. ii, figs. 8, 10, 12, 1850.

anterior end, in the presence of the ventral groove between them, the lateral groove above them, and the form of the caudal process and its papillæ.

The *body* is about an inch in length, with about twenty-eight setigerous segments, rounded dorsally and grooved ventrally, tapered at each end, especially posteriorly, where it contracts gently to the abruptly diminished caudal process, which forms a short cone with a few short terminal cirri (Plate LXXXVIII, fig. 2). Dorsally the body is marked by about twenty-eight or thirty transverse brown bars, with a fine dusting of the same pigment between and beyond them. These bars appear to have a definite position, a line drawn from their extremities striking the middle of each space between the lateral pigment-touches (so-called eyes). The densest dusting of pigment appears to be on the terminal regions anteriorly and posteriorly, the base of the caudal process, indeed, having a continuous brown blotch. The dorsal surface in life is ciliated.

The digestive system has a short proboscis, cup-shaped in extrusion, and a transversely grooved region occurs behind the lower lip. Claparède describes a pair of blind appendages of the canal, the ends of which reach the ninth segment. He also mentions an orange-red dorsal blood-vessel, and a ventral trunk on the ganglionic chain, each connected with the other by a lateral branch in every segment. The branch in the eighth segment presents a large dilatation on each side, the blood thus passing from the dorsal to the ventral trunk. A sub-intestinal vessel, and a lateral vessel on each side in the line of the bristle tufts, complete the main series.

De Quatrefages (1850) gave an account of the circulation of this genus, describing and figuring a posterior auricle and a pair of ventricles in front. The red blood flows forward in the intestinal lacunæ, and enters the auricle, part going by the dorsal trunk to the head, then the lateral organs (ventricles) contract and drive it into the ventral trunk.

When the line of transverse section passes through a pigment-speck (eye), it is found to consist of a capsule with dark pigment internally, and distally of a pale region, which may perform the functions of a lens. The organ is situated on the upper edge of the ventral swelling, just outside the upper insertion of the oblique muscle (Fig. 96).

De Quatrefages shows a distinct nerve-twig going to the organ.

Externally these pigment-spots occur in the groove above each ventral longitudinal muscle, and are fully twenty in number, though none of the preserved examples has a complete series.

Though at first sight the bristles (Plate C, fig. 11) are not evident, yet they occur in a rudimentary form in each segment, forming minute tufts of simple tapering bristles, best seen towards the caudal region, where the four or five last tufts, as Claparède showed, are double.

Reproduction.—De Quatrefages (1850) thought the reproductive period was in spring, and that the elements escaped by a canal placed above (on the dorsum) the terminal portion of the intestine, and opening into it.

Claparède described the eggs as ellipsoidal, and thought they escaped partly through the anterior region of the body and partly by the vent, for he found that they entered the gut by a special aperture in the twenty-fourth segment.

Lo Bianco (1909) notes that the spawning period might extend throughout the year —at any rate, from March to October.

Dujardin[1] (1839) considered that this form, his *Nais picta*, belonged to the same group as *Nais digitata*, as having eyes, not only in their usual position, but along the body. His description and figures are quite recognisable.

Grube (1851) placed this form along with the genus *Dero*. His later view that *Polyophthalmus* is only a genus of the Opheliidæ would appear to be reasonable. It is, further, interesting to note how closely the structure of the body-wall in *Polygordius* approaches that in the present group, as shown long ago,[2] and as De St. Joseph more recently corroborated.

Claparède (1864) gave a detailed account of this species from Port-Vendres, his view being that it formed a special type characterised by the muscular bands which divide the cœlom into three spaces, and by the presence of the cephalic pouches (grooves). The muscular bands, however, appear to be only the oblique muscles.

De Quatrefages[3] (1865) describes the head as of three lobes, and Carus (1885) follows him, but, as Grube pointed out, this is a misapprehension.

E. Meyer[4] (1882) gives a careful account of the small and simple "Seitenorgane" of this species. He also describes a structure like a cardiac body in the heart, but, as it is fastened to the intestinal epithelium, there is doubt as to its exact nature. The segmental organ opens just above the lateral (corporeal) eye-spot. His figures are excellent.

Lessona[5] (1884) gives a careful structural description of this form, especially of the nervous system, eyes, and sense-organs. He shows no hypoderm between the cuticle and the ganglia of the cord. His lateral organs of sense recall those of larval fishes.

De St. Joseph (1898) thought that it is probable, as Monticelli holds, that *P. Ehrenbergi*, De Quatrefages, *P. dubius*, De Quatrefages, and *P. pallidus* all pertain to this species. The same author[6] (1906) describes the body as pale or clear brown with mosaic patches of brown grains on the dorsum and sides throughout. The number of anal papillæ is from eight to ten, and of the lateral eyes from ten to sixteen.

Fauvel (1907) considers *P. Ehrenbergi* and *P. dubius* of De Quatrefages and *P. pallidus* of Claparède as the same form.

Genus LXXXIV.—Ophelina, *Hansen*,[7] 1882.

Cephalic region produced into a long tapering snout with a terminal enlargement like a probe-point. Lateral projections in place of the nuchal pits. Body resembles that of *Ammotrypane* in regard to bristles and cirri. Anal scoop rather long, with a few terminal cirri.

[1] 'Ann. Sc. nat.,' 2e sér., t. xi, p. 293, pl. vii, figs. 9—12.
[2] 'Ann. Nat. Hist.,' ser. 4, vol. xvi, p. 369.
[3] 'Annelés,' t. ii, p. 203.
[4] 'Arch. f. mikr. Anat.,' Bd. xxi, p. 791.
[5] 'Mem. Accad. Torino,' ser. 2, t. xxxv, p. 309, tav., figs. 1–15.
[6] 'Ann. Sc. nat.,' 9e sér., t. iii, p. 232.
[7] Hansen applied the name to two forms procured during a voyage to Brazil and La Plata.

Ophelina Kükenthali, *McIntosh*, 1908.

Specific Characters.—Head pointed, a slender clavate papilla projecting beyond it. Body 25 mm. long, resembling *Polygordius*, tapered a little anteriorly and posteriorly, rounded dorsally, and grooved ventrally. It diminishes slightly posteriorly, and then abruptly narrows to a short, cylindrical, caudal process, with a smooth edge and no bristles.

Synonym.

1908. *Ammotrypane* (*Ophelina*) *Kükenthali,* McIntosh. Ann. Nat. Hist., 8 ser., vol. i, p. 387.

Habitat.—Dredged at 795 fathoms in the 'Porcupine' Expedition of 1870.

Head pointed, with a slender clavate papilla projecting beyond it. No eyes in the preparation. Nuchal organs probably present, though they are not distinct in the spirit-specimens.

Body about 25 mm. in length (in spirit) and having the aspect of a *Polygordius*, tapered a little anteriorly and posteriorly, rounded dorsally, and grooved ventrally. The ventral longitudinal muscles run on each side from the region of the mouth to the base of the caudal process, and have the usual lateral groove above them, but, so far as observed, neither bristles nor pigment-specks are present. The mouth occupies the ordinary position on the ventral surface a short distance behind the tip of the snout. The body slightly diminishes posteriorly, then somewhat abruptly narrows to the short cylindrical caudal process, which presents a smooth edge posteriorly. In one of the examples the terminal edge is oblique, in the other it is rounded, but, as both examples appear to have been more or less dried, uncertainty remains on this point.

The slender, smooth, glistening body and the absence of bristles, cirri, and papillæ on the caudal process are features of moment.

Hansen[1], in his original account of a species of *Ophelina*, gave no description of the genus, and associated it with another species which differed in the form of both the head and the caudal region. Both came from South America.

Genus LXXXV.—Travisia, *Johnston*, 1840.

Body short, spindle-shaped, without a ventral sole or ventral groove; segments generally three-ringed; posterior segments two-ringed. Thicker posteriorly, with on each side on broader segments double lateral processes (feet) without papillæ. Two tufts of bristles on each side. Branchiæ occur on the anterior segments, but disappear posteriorly.

[1] 'Mém. Couronnés, etc., l'Acad. Roy. Belgique,' t. xliv, p. 16, pl. v, figs. 1—4.

1. Travisia Forbesii, *Johnston*, 1840. Plate LXXXVIII, fig. 3; Plate XCV, figs. 7—7 *b* —head, tail, and glands; Plate CIII, fig. 4—bristle.

Specific Characters.—Head a simple pointed cone. Body about 25 mm. long, and consisting of a larger elliptical anterior region of fourteen segments and a subcylindrical posterior region of about thirteen segments. The anterior region gradually increases in diameter to the middle, then diminishes. Second segment has one ring, and is achætous. The succeeding two or three narrow rings have a dorsal and a ventral tuft of bristles with an intermediate branchial cirrus. The posterior segments are characterised by two short and somewhat lobate papillæ on each side. Anal segment has a ring of six blunt papillæ with the anus in the centre.

Synonyms.

1840. *Travisia Forbesii,* Johnst. Ann. Nat. Hist., vol. iv, p. 373, pl. xi, f. 11—18.
1843. *Ammotrypane œstroides,* H. Rathke. Nova Acta Acad. Leop.-Car., xx, p. 192, Tab. x, f. 9—19.
„ *Ophelia mammilata,* Œrsted. Annul. Dors., p. 53, Tab. 8, f. 103, 112, 114, 119–120.
„ „ „ idem. Ann. Dan. Consp., p. 45.
1844. „ „ idem. Arch. f. Naturges., x, p. 110, Tab. iii, f. 21—23.
„ „ „ idem. Reg. Mar., p. 78 (fide Mgrn.).
1851. *Travisia Forbesii,* Grube. Fam. Annel., p. 71.
1857. „ *œstroides,* Koren. Nyt Mag. f. Naturvid, ix, p. 94.
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 119.
1861. „ „ idem. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 53.
1864. „ „ Kölliker. Köngl. Bericht, p. 10.
1865. *Travisia Forbesii,* Johnst. Cat. Worms Brit. Mus., p. 220, vol. xix, figs. 11—18.
„ „ *œstroides,* De Quatrefages. Annel., ii, p. 274.
„ „ *Forbesii,* idem. Ibid., p. 276.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 125.
1879. „ „ Tauber. Annul. Danica, p. 109.
„ „ „ Théel. Kongl. svenska Vet. Akad. Handl., Bd. 16, p. 49.
1883. „ „ Wirén. Chæt. 'Vega' Exped., p. 406.
1884. „ „ Levinsen. Nord. Annel., Vidensk. Meddel. Foren. Kjöbenh., p. 119.
1885. *Ammotrypane œstroides,* Pruvot. Arch. Zool. expér., 2e sér., t. iii, p. 303, pl. xi, fig. 8.
„ „ „ (nerv. syst.), Pruvot. Arch. Zool. expér., 2e sér., t. ii, p. 303, pl. xv, figs. 3—11.
1886. *Travisia Forbesii,* Marenzeller. Internat. Polarforsch., p. 14.
1887. „ „ Kükenthal. Jenaische Zeitschr., t. xx, p. 516, pl. xxxii, figs. 1—14 (nerv. syst.).
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 102.
1896. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 332.
1897. „ „ Michaelsen. Polych. deutsch. Meere., p. 136.
1898. „ „ De St. Jaseph. Ann. Sc. nat., 8e sér., t. v, p. 381, pl. xxii, fig. 200.
1904. „ „ Ehlers. Abhandl. Köngl. Gesell. Wiss. Göttingen, Bd. iii, p. 46.
1906. „ „ Bohn. Ann. Sc. nat., 9e sér., t. 3, p. 116 (movements).
1907. „ „ Fauvel. Bull. Inst. Ocean., No. 107, p. 24.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. i, pp. 379—387.

1908. *Travisia Forbesii,* Moore. Proc. Acad. Nat. Sc. Philad., p. 354.
„ „ „ Ehlers. Deutsch. Tiefsee-Exped., p. 9.
1913. „ „ Augener. Zool. Anzeig., Bd. xli, p. 267.

Habitat.—First procured by John Goodsir and Edward Forbes, probably in Shetland (G. Johnston). Stomach of flounder, St. Andrews (E. McIntosh). Dredged in 5 fathoms on a great stretch of sand off Paible, North Uist; also in Bressay Sound in muddy sand in 18 fathoms; West Voe of Scalloway in muddy sand at 18 fathoms—a region where it occurred in greatest numbers.

It ranges to Spitzbergen, Greenland, Iceland, and Scandinavia (Malmgren, Fauvel); Norway (M. Sars and Canon Norman); North Sea, 300 fathoms; Shores of France (De St. Joseph); Atlantic Coast, U.S.A. (Verrill); Northern and Behrings Seas (Wirén); Franz-Joseph-Land (Augener); Cape of Good Hope (Ehlers).

The body-wall in *Travisia* (fig. 100) quite differs from that in the ordinary Opheliidæ,

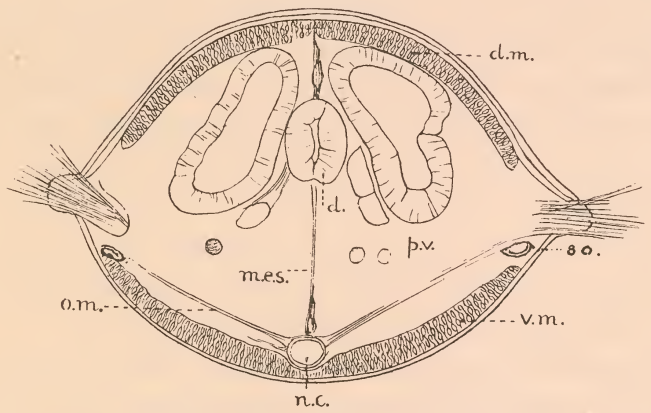

Fig. 100.—Transverse section of the anterior region of *Travisia Forbesii,* Johnst. *mes.* Ventral mesentery.

and conforms rather to that of the Scalibregmidæ, for the tough glistening cuticle so characteristic of the former is here an extremely thin superficial layer on the thick hypoderm. A basement-tissue layer and circular muscular fibres lie within, the circular being especially developed in the lateral region, where the fibres of the oblique slope inward to the nerve-cords. These circular fibres remain massive for some distance below, then gradually diminish to a narrow belt in the mid-ventral line. The thickened region is pointed internally in transverse section, the oblique muscle coming from the apex, passing to the upper region of the nerve-cords, and along the side to the ventral edge. The capsule of the cords is intimately fixed to the circular coat on the ventral border. Slender as the oblique muscles are, they mark off a space, as in the Opheliidæ, for the ventral longitudinal muscles, which are moderately developed. The segmental organ (*so.*, Fig. 100), which is comparatively large, also occurs in the same area. The dorsal longitudinal muscles form a somewhat thin layer, touching in the mid-dorsal line and extending downward to the origin of the oblique, the lateral and inferior parts of the muscles being thicker than the dorsal. The upper area is occupied by the alimentary-canal with its rugose inner surface, and by a blood-vessel in the mid-dorsal line. The slender oblique muscles have not separated the infero-lateral areas so distinctly as in *Ophelia* and *Scalibregma*, but they are clearly indicated.

Head a simple pointed cone, somewhat flattened ventrally.

Body (Plate LXXXVIII, fig. 3) about $\frac{3}{4}$ in. in length, and consisting of two dissimilar regions, a broader elliptical anterior and a subcylindrical posterior. The former has fourteen segments (though this distinction is more or less arbitrary), which increase gradually in diameter to the middle, and decrease posteriorly. The second segment has one ring, and is devoid of feet. The succeeding have two or three narrow rings, a dorsal tuft of bristles, a branchial filament (cirrus), a circular pore, and a shorter tuft of ventral bristles. The mouth opens on the ventral surface, between the second and third segments, a small groove running forward to the former in well-marked specimens.

In fine examples from Greenland the anterior runs into the posterior region without evident distinction—other than the gradual disappearance of the rings on the segments. Moreover the entire number of segments seems to be smaller than stated by Dr. Johnston, the total number varying from twenty-five to twenty-seven or twenty-eight.

The posterior region has about thirteen segments, more boldly marked than in front, and thickened laterally where two short and somewhat lobate papillæ occur, a narrow ring being present between each thicker one. A short cirrus arises below the upper papilla near a tuft of bristles. The penultimate segment is small and devoid of bristles. The terminal or anal segment has a cup-like circle of six soft obtuse papillæ (Johnston), with the vent in the centre. This region seems to be occasionally mutilated, so that it ends abruptly in a round disc.

The skin is boldly reticulated throughout; the isolated granular areas, which are irregularly pentagonal or hexagonal, being separated by pale lines. It rapidly secretes a mucous coating to which sand-grains and other *débris* adhere.

In life it is of a uniform, pinkish colour, slightly paler or straw-coloured laterally and posteriorly, and somewhat iridescent on both dorsal and ventral surfaces. The viscera *in sitû* were pinkish, and a coil extruded through a rupture was gamboge-yellow. The branchial cirrus has a streak of red. A distinct, median, ventral blood-vessel is apparent, but no dorsal. Many small, whitish bodies (ova?) rolled about in the perivisceral fluid of the posterior segments in August.

In an example, measuring about 15 mm., from Norway (Dr. Merle Norman's), the entire exterior is enveloped in mucus which clings tenaciously to the surface and is dotted with sand-grains. The posterior or caudal region seemed to have only eight or nine segments. An interesting feature was the occurrence on the posterior border of one of the cirri of a bifid process so that the cirrus truly resembled a gill.

Considerable variation is met with in the length of the posterior region of the body and in the number of the cirri—to judge from Dr. Johnston's drawing and the figures of Rathke. Those procured have all been small, and instead of having thirteen posterior segments, as Dr. Johnston states, nine or ten are present. The largest examples observed have been procured in Greenland.

The bristles are comparatively short, simple, slender structures (Plate CIII, fig. 4, and Plate CIV, fig. 8), tapering gradually to a fine point. They are most conspicuous anteriorly and posteriorly.

Habits.—In captivity it is inert, rolling about on its side, thrusting its snout hither and thither and elongating the anterior and posterior regions to a slight extent.

The mud amongst which it lives is sometimes, as in the West Voe of Scalloway, odoriferous from the decaying fuci, algæ, and other forms.

Dr. George Johnston (1840) procured the first example from Profs. John Goodsir and Edward Forbes, and, as the specimen was somewhat softened, he was in doubt as to its exact position, but he concluded that it was closely related to *Scalibregma inflatum*. In his catalogue (1865) he placed the genus between *Ophelia* and *Eumenia*, with a good description and figure.

H. Rathke (1843) included this form under his genus *Ammotrypane* as *A. æstroides*, and his description and figures are characterised by his usual care. He further gives an account of its general anatomy with figures, and he represents, though he did not correctly name, the segmental organs with external openings.

Travisia was ranged by Grube (1851) under the family Opheliacæ of the tribe Limivora, and he correctly entered the synonyms.

Schmarda[1] (1861) found a very similar form on the coast of Chili, though his figure of the foot and the bristles differs.

De Quatrefages (1865) entered this form under the titles *Travisia Forbesii*, *Ophelia mammilata*, and *O. æstroides*—all in the family of the Opheliidæ.

Grube (1869), like Malmgren, included *Travisia* in the second division of his Opheliaceen.

Following the usual procedure, Levinsen[2] (1883) placed *Travisia* at the end of the Opheliidæ.

Travisia Kerguelensis of the 'Challenger'[3] differs comparatively little from the common species.

De St. Joseph (1898) speaks of the strong and disagreeable odour of this species, but whether such is due to its surroundings is not explained. Certainly in the midst of decaying animal and vegetable structures in the quiet voes of Shetland the odour is strong —so strong, indeed, as on one occasion to cause two boatmen almost to cease work with the dredge—yet *Travisia* and the beautiful little *Lima* were common. This author also found a white variety.

Louis de Reau[4] (1908) has recently examined the structure of the body-wall of *Travisia Forbesii*, and is of opinion that externally is an epithelium of cubical cells covered by a cuticle giving passage to the papillæ, which are distributed and fused below the surface so as to simulate a second epithelium. He considers, in short, the arrangement as an exaggeration of the condition of the papillæ in *Stylarioides plumosa*, *Flabelligera affinis*, and others, the maximum complication taking place in *Travisia Forbesii*, in which the papillæ are fused.

2. Travisia Gravieri, *McIntosh*, 1908. Plate XCV, fig. 8.

Specific Characters.—Snout terminating in a smooth pointed process. Body small, 5 mm. long, resembling a Dipterous larva, gently dilating behind the snout, and continuing

[1] 'Neue Wirbell. Thiere,' I, ii, p. 49, Text-fig.

[2] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 119.

[3] 'Report Annelida,' p. 357, pl. xliii, fig. 10; pl. xxxvi, figs. 1 and 2, 1885.

[4] 'Compt. Rend. Acad. Sc. Paris,' April 13th.

as a rounded, ringed sac to the posterior end, where a slight diminution occurs before the abrupt termination. It is closely ringed, and the anterior dorsal surface presents the tesselated condition characteristic of *Scalibregma*. A trace of a median groove exists ventrally. The feet are represented by a pair of minute papillæ every third ring, but no bristles could be found. It terminates posteriorly in a short, almost cylindrical, process with a fissured edge.

Synonym.

1908. *Travisia Gravieri*, McIntosh. Ann. Nat. Hist., 8 ser., vol. i, p. 383.

Habitat.—Dredged in 539 fathoms in the 'Porcupine' Expedition of 1870, Station No. 9.

A small form resembling the larva of one of the Diptera, and measuring about 5 mm. in length. The snout terminates in a smooth pointed process, the body gently dilating thereafter, and continuing as a rounded, ringed sac to the posterior end, where a slight diminution occurs before it somewhat abruptly terminates. The rings in the contracted posterior region encircle the body to the central cylindrical caudal process, which is fissured or crenate at the tip. The dorsal surface is convex; the ventral concave from before backward. The body is closely ringed from the base of the prostomium to that of the caudal process, the anterior dorsal surface especially showing the tesselated condition characteristic of *Scalibregma*, but the ventral surface is smoother, and has in the middle line a faint trace of a groove. The posterior rings have a crenate posterior edge.

At first sight feet appear to be absent, but close inspection shows a pair of minute papillæ in a row every third ring.

Two of the minute feet were examined, but no bristles were found, though a slender papilla, slightly tapered at one end and apparently ciliated, occurred in connection with the foot, but whether external or internal is unknown; certainly no trace was seen externally under a low power. The degeneration of the feet is in this form carried out almost to their disappearance.

Family XVI.—Scalibregmidæ, *Malmgren*, 1867.

This family approaches the Arenicolidæ in various respects, such as the somewhat tesselated condition of the skin anteriorly and the limivorous habits, but the distinctions are nevertheless evident. The prostomium is small, either with or without short lateral processes, and has the lateral nuchal grooves through which the nuchal organs may be protruded. Eyes are usually absent. The body is comparatively short, sometimes enlarged anteriorly or fusiform in outline, and gills, when present, are generally anterior, and few in number (four to five). The segments are annulated, the dorsal and ventral divisions of the feet are nearly equal, and carry long, simple, and shorter, forked bristles, whilst between them a protrusible sense-organ exists. The pharynx is smooth, and the alimentary canal simple, terminating in an anus with or without cirri. The heart is median, and is an enlargement of the dorsal vessel. Narrow ciliated nephridia occur in almost all the segments.

The body-wall in *Scalibregma*[1] is remarkable for its great muscularity, especially posteriorly (Fig. 101), the thin cuticle covering a thick layer of hypoderm, as in *Travisia*, and which rests on basement-tissue. Beneath is a thick circular coat, the outer fibres of which pass downward to the ventral surface and a few meet across the middle line, over the nerve-area, whilst others seem to pass into the oblique, thus making a muscular commissure. The dorsal belt of these circular fibres is of great strength in this region, and extends downward to the origin of the oblique with which some of its fibres join. The rest of the fibres pass downward between each foot to form a thick layer in the ventro-lateral area, some of the central fibres meeting, as already noted, over the nerve-cords, whilst others appear to join the oblique of the opposite side. The oblique are powerful muscles which bound the ventro-lateral areas internally, and enclose a space for the ventral longitudinal muscles, which form a semicircular mass on each side. This space, as in allied forms, encloses the segmental organs, which open externally at the

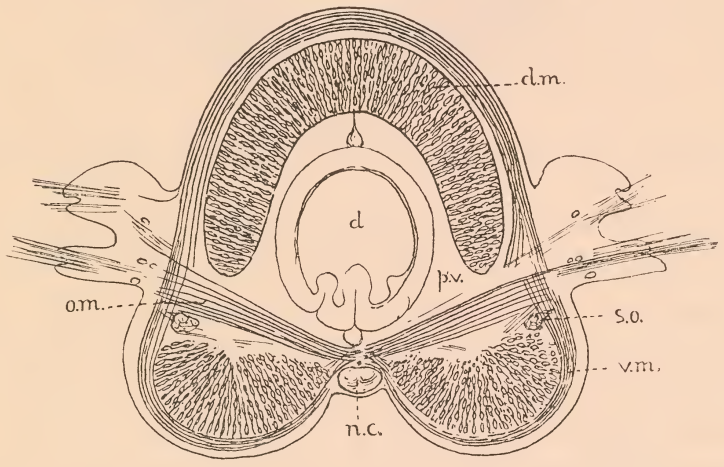

Fig. 101.—Transverse section of the posterior region of *Scalibregma inflatum*, H. Rathke, from Lochmaddy.

upper and outer border, and ova and other contents of the body-cavity enter it. The dorsal longitudinal muscles are fused and form a thick arch over the cœlom, the lower border on each side being somewhat thinned as it approaches the oblique. The alimentary canal in this part has a thin external wall of circular fibres, and apparently a few longitudinal, whilst internally is a layer of basement-tissue bearing the thick glandular coat. Its contents are sand-grains, mud, fine siliceous spicules and cellular *débris*. Ova also occur in the cavities of the feet, the dorsal and ventral lobes of which contain vermiform, striated, glandular tissue which stains deeply. The nerve-cords have a thick granular and fibrillar layer, then the hypoderm and cuticle externally, whilst internally are the circular fibres into which the oblique pass, and thus form a resistant boundary.

Such a structure as the foregoing shows relationships with that of the Opheliidæ in respect to the spaces of the body-cavity and the muscular system, but it differs from that family in the structure of the skin and in the form of the branchiæ.

In *Eumenia Jeffreysii* (*Lipobranchius* of some) the cuticle and hypoderm agree with those in *Scalibregma*, a very thin cuticle investing the thick granular hypoderm, which is covered with papillæ so as to make a tesselated surface. Beneath is a peculiar and deep

[1] 'Proc. Roy. Soc. Edinb.,' Session 1876—7.

basement-layer which is minutely reticulated like a form of chordoid tissue and apparently possesses great elasticity. It stains so deeply that its structure is obscured. The streaks in the hyaline substance of this coat may be connected with modified nuclei assuming the form of elongated corpuscles which may be branched and join other fibres, or these represent fibrillar structures in the hyaline tissue.

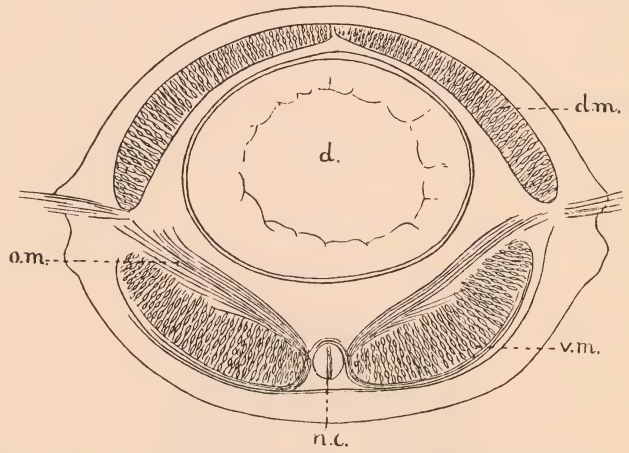

Fig. 102.—Transverse section of the anterior third of *Eumenia Jeffreysii*, McIntosh. Letters as before.

Within is a thin layer of circular fibres which, reaching the nerve-cords, turns upward and is lost in the oblique and other fibres at this part. Very few fibres, if any, pass outside the nerve-cords, which have the thick basement-tissue, the hypoderm, the cuticle, and a special fold externally. The oblique muscles pass down by the side of the nerve-cords and are fixed to the basement-tissue, though it is possible a few fibres may cross below the nerve-cords to join those of the other side, and thus cause ambiguity with regard to the circular fibres (Fig. 103). The upper arch of the body has moderately

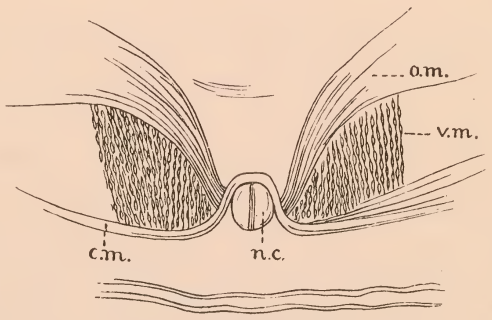

Fig. 103.—Arrangement of the parts in a transverse section of the nerve-cord in *Eumenia Jeffreysii*, McIntosh.

developed dorsal longitudinal muscles, which touch in the middle-line, and somewhat increase in thickness in the neighbourhood of the oblique—inferiorly. The oblique muscles do not seem to affect the outline of the ventral region in any marked degree. The ventral longitudinal muscles are also moderately developed and stretch from the oblique to the nerve-cords. The arrangement of these and the dorsal lean to the type of *Arenicola* in which no very marked differentiation of the several muscles of the body-wall is apparent.

The contents of the intestine consist of fine sandy mud with fragments of crustaceans, sponge-spicules, Foraminifera, Radiolarians, and other organisms.

De Quatrefages (1865) was uncertain about the position of this family, though he placed it after the Arenicolidæ, yet he made a new genus for the *Eumenia* of Œrsted.

Carus (1885) places the Scalibregmidæ after the Opheliidæ.

The Scalibregmidæ were ranged by Levinsen[1] (1893) along with the Telethusæ under the Arenicolina, an arrangement which meets with no objection, though there are obvious differences. He commences with *Eumenia*, the only other genus mentioned being *Scalibregma*.

De St. Joseph (1894) divided the family into two groups, viz. those with and those without branchiæ. Those with branchiæ included the two genera *Scalibregma* and *Eumenia*, whilst those devoid of branchiæ were *Sclerocheilus*, Grube, and *Lipobranchius*, Cunningham and Ramage.

Benham (1896) grouped the Scalibregmidæ under his Nereidiformia, in the fifth sub-order Scoleciformia, and close to the Arenicolidæ.

Ashworth (1904) gives a good classification of the family, distinguishing the main groups, I and II, thus: I. Head with antero-lateral tentacles. Body swollen anteriorly, feet, after the fifteenth, prominent, with a laminate dorsal and ventral cirrus, and with gills on the anterior segments (*Scalibregma*), or none (*Pseudo-scalibregma*). In a sub-section (B) the simple rounded feet do not form laminate appendages, and the ventral cirri, if present, are confined to the posterior region. Strong curved bristles on the first bristled segment (*Schlerocheilus* and *Asclerocheilus*). II. In this group the head has a median groove; no tentacles. Body maggot-shaped. Feet represented by dorsal and ventral papillæ. No anal cirri. Gills on the anterior segments present or absent (*Eumenia* and *Lipobranchius*). The family is allied to the Opheliidæ and Arenicolidæ (Telethusæ). The author states that the nerve-cord lies in contact with the epidermis and outside the circular muscular coat. He does not include *Travisia* in the group.

Genus LXXXVI.—Scalibregma, *H. Rathke*, 1843.

Head somewhat T-shaped, the anterior angles bearing tentacles and the posterior the nuchal organs. Body swollen anteriorly, tapered posteriorly, arenicoliform. Four or five pairs of gills anteriorly. Feet from the fifteenth project prominently, with a dorsal and ventral cirrus or lamella, and setigerous processes. Sense-organ between the dorsal and ventral divisions of the foot. The segmental organs consist of a funnel, a fine straight tube from it to the loop formed by a U-shaped tube, one of the limbs leading to the terminal duct which opens just below and slightly anterior to the base of the ventral division of the foot (Ashworth[2]). These organs are numerous.

This genus was one of H. Rathke's important additions to the Norwegian fauna (1843), and he truly pointed out its relations to *Arenicola*. His figures were as good as his description.

The genus *Scalibregma* followed *Eumenia* under the Opheliacea of Grube (1851) as one of the Limivora.

[1] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 180.

[2] 'Quart. Journ. Micr. Sci.,' vol. xlv, n.s., p. 282.

Hansen[1] (1879) describes two new species from the Norwegian Expedition of 1876 viz. *Scalibregma abyssorum* and *S. parva*, the snout of the former being rounded, and the bifid bristles of both being represented as smooth between the forks—an abnormal condition. The form of the foot, which has dorsal and ventral projections of the setigerous processes, approaches that in *S. inflatum*.

1. Scalibregma inflatum, *H. Rathke*, 1843. Plate LXXXVIII, fig. 4; Plate CIII, figs. 7—7*b*—capillary and forked bristles.

Specific Characters.—Head truncated anteriorly with a lateral tentacle on each side. Two frilled nuchal organs. Body, in large examples, about three inches in length, somewhat fusiform, though at the anterior third the enlargement is greatest, abruptly tapered anteriorly and more gently diminished posteriorly. Convex dorsally, with a depressed mid-ventral line from end to end in the preparations. Segments sixty-three or more. It is closely ringed and tesselated. Segments of four rings, the exceptions being the four anterior segments, the third bearing the foot. The last four have no feet. Posteriorly is a papillose vent with four or five cirri ventrally. Four to five pairs of branchiæ,[2] commencing on the second bristled segment and increasing in size from front to rear. Proboscis a somewhat short, lobular organ—often with a truncate tip. Feet in front represented by a pad bearing the dorsal and ventral papillæ with the bristles. About the sixteenth or eighteenth bristled segment the feet become more prominent, a small dorsal cirrus occurring above the setigerous lobe, by-and-by a ventral cirrus likewise appears, and both assume considerable prominence posteriorly. A retractile sensory papilla, midway between dorsal and ventral lobes of the foot.

Bristles long, translucent, simple and tapering, and shorter bifid forms with spines in the fork.

Synonyms.

1843. *Scalibregma inflatum*, H. Rathke. Nova Acta Acad. Leop.-Car., xx, i, p. 184, Tab. ix, figs. 15–21.
1846. *Oligobranchus roseus*, Sars. Fauna Litt. Norveg., i, p. 91, Tab. 10, figs. 20—27.
„ „ *grœnlandicus*, idem. Ibid., p. 92.
1851. *Scalibregma inflatum*, Grube. Fam. Annel., pp. 71 and 135.
1853. „ *roseum* (*Oligobranchus*), Sars. Nyt Mag. f. Naturvid, vii, p. 381.
„ „ „ idem. Ibid., vii, p. 381.
1859. „ *inflatum*, Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 121.
1861. „ „ idem. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 54.
1864. „ „ Kölliker. Kurzer Bericht, pp. 12 and 14.
1865. „ „ De Quatrefages. Annel., t. ii, p. 268.
1867. „ „ Malmgren. Annul. Polych., p. 77.
„ „ „ Wirén. Köngl. svenska Vet. Akad. Handl., t. xxii, text and Taf. ii, figs. 14 and 15; Taf. iii, fig. 1.

[1] 'Nyt Mag. f. Naturvid.,' Bd. xxix, p. 6, pl. v.

[2] Dr. Ashworth gives four as the number, but he had not the advantage of seeing living specimens, 'Quart. Journ. Micr. Sci.,' vol. xlv, N.S., p. 243.

1868. *Scalibregma inflatum,* Sars. Christ. Vid.-Selsk. Forhandl., p. 10 (sep. copy).
1873. ,, ,, idem. Nyt Mag. f. Naturvid., xix, p. 246.
1874. ,, *inflata,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. ,, ,, idem. Invert. and Fishes St. Andrews, p. 125.
1877. ,, *inflatum,* Marenzeller. Denkschr. K. Akad. Wiss. Wien, Bd. xxxv, p. 34 (sep. abbr.).
1878. ,, ,, McIntosh. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 506.
1879. ,, ,, Tauber. Annul. Danica, p. 109.
,, ,, ,, Théel. Kongl. svenska Vet. Akad. Handl., Bd. 16, p. 51.
1880. ,, *inflata,* McIntosh. Ann. Nat. Hist., ser. 4, vol. vi, p. 271.
1883. ,, *inflatum,* Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 132.
1885. ,, ,, var. McIntosh. 'Challenger,' Annel, p. 359, pl. xliv., figs. 3, 4, pl. xxii[A], fig. 21.
1886. ,, ,, Wirén. Köngl. svenska Vet. Akad. Handl., Bd. 22, ubique (Anat.), pls. ii and iii.
1889. ,, ,, Marenzeller. Arch. f. Naturges., lv, p. 129.
1894. ,, ,, Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 109.
1896. ,, *inflata,* Benham. Camb. Nat. Hist., vol. ii, p. 334.
1897. ,, *inflatum,* Michaelsen. Polych. deutsch. Meere, p. 138.
1898. ,, ,, idem. Grönländ. Annel., p. 127.
,, ,, ,, var. *corethusa* (epitokous), idem. Ibid.
1900. ,, ,, Ehlers. Schwed. Magellan. Annel., p. 14.
1901. ,, ,, idem. Polych. Magell. u. Chil., p. 180.
1904. ,, ,, Journ. M. B. A., vol. vii, p. 231.
1908. ,, ,, McIntosh. Ann. Nat. Hist., ser. 8, vol. i, pp. 379.
,, ,, ,, Moore. Proc. Acad. Nat. Sc. Philad., p. 356.
1909. ,, ,, Ashworth. Rep. Fisheries Ireland, 1908, ii, p. 3.
,, ,, ,, Moore. Proc. U. S. Nat. Mus., vol. xxxvii, p. 143.

Habitat.—Off Millport, Cumbrae (Kölliker). In muddy sand at low water-mark of ordinary tides, Lochmaddy, and also dredged in 4 or 5 fathoms in Ardmaddy Bay in muddy clay. In muddy sand, Bressay Sound, Shetland (small examples). Stomach of haddock and flounder, St. Andrews (E. McIntosh, 1867). Malahide; 23–38 fathoms S.W. Ireland, and Valentia Harbour (J. G. Jeffreys). Lough Slyne, Co. Cork; Valentia, in 2 fathoms in soft mud (R. I. A., 1886). 18 fathoms Bressay Sound, and in Vatsland Bight, Shetland; off the Hebrides (J. G. Jeffreys). All the Irish examples are small. 257 fathoms at Station 8 in the 'Porcupine' Expedition of 1870 (no branchiæ). Plymouth (Allen). Fahy Bay, Ireland (Ashworth).

'Challenger,' between Prince Edward Island and Kerguelen, and off N.W. Coast of New Zealand; Magellan (Ehlers); 80 fathoms outside Godhavn harbour, 'Valorous,' 1875. Spitzbergen, Greenland, Norway, Sweden, and Finmark (Malmgren). North Sea. Barents' Sea (McIntosh). 300 fathoms off Norway (Sars). Magellan (McIntosh and Ehlers). Small forms (young) at various stations off Norway (Canon Norman). Atlantic Coast, United States of America (Verrill). Arctic Sea (Marenzeller). N. Pacific Coast of N. America (Moore).

Head truncated, with a distinct lateral tentacle on each side, and usually carried transversely. Two curiously frilled nuchal organs occur on the head posteriorly.

Body (Plate LXXXVIII, fig. 4) about 3 inches in length, abruptly tapered in front, more gently diminished posteriorly, and closely ringed besides being tesselated throughout, the surface, indeed, resembling a pavement of minute square red bricks. These markings disappear in imperfectly preserved examples, and thus are absent from representations made from them; yet Rathke faithfully shows and describes them. The peristomial segment is two-ringed and achætous. The mouth opens on the ventral surface between this and the first bristled segment, and is bordered by papillæ or ridges in front and behind. This position is such that at first sight it seems to open on the segment behind the peristomium. The next three have three rings, the middle bearing the foot. All the succeeding segments have four rings, the feet being on the third ring in each. The last four segments are devoid of feet. The body is terminated by a papillose vent, beneath which are four or five cirri, the latter number having also been found by Dr. Ashworth.[1] In small examples dredged by Canon Norman in Norway the caudal cirri are unusually long and slender.

In life the animal is of a dull brick-red throughout, the tesselated portions being minutely dotted with yellow. The posterior region of the body is often discoloured from the contents of the gut, being dull greyish, and thus throwing the paler lobes of the feet into relief. A slight iridescence occurs on the ventral surface, along which the large ventral blood-vessel passes.

The branchiæ commence on the first bristled foot, and increase in size from the first to the fifth and last tuft. In smaller specimens from the West Coast of Ireland only four branchiæ are present, but as the first even in a large example in life is very small, such may be due to retraction within the surface.

Certain specimens agree in all respects with the typical form, but the branchiæ are entirely absent, and Dr. Ashworth states that he has observed the same condition in a few American examples. It is a question whether such should be regarded as specifically different.

The anterior feet are represented by a pad bearing the dorsal and ventral papillæ, but about the eighteenth they become more prominent, and a small dorsal cirrus appears above the setigerous lobe, and by-and-by a ventral cirrus is evident, and both assume considerable prominence posteriorly. A retractile sensory papilla with a tuft of sensory hairs occurs between the dorsal and ventral lobes of the foot.

The anterior bristles (Plate CIII, figs. 7 and 7 *a*) are of considerable length, translucent, finely tapered from base to apex, and smooth. None of the forked forms occurred in front, but they appeared before the twentieth foot, and whilst the long simple forms extend far beyond the setigerous papilla, these (Plate CIII, fig. 7 *b*) project but little beyond the surface, though they probably can be exerted to a greater extent, as indeed they frequently are in the posterior feet (*e. g.* beyond the thirtieth). The muscles moving the bristles are developed as long narrow slips, and, as the axes of the two kinds of bristles usually differ, their functions probably diverge.

In the middle line between the dorsal and ventral divisions of the foot is a rounded papilla, the lateral sense-organ of Ashworth, who gives a careful description of its structure.

The first bristles occur on the second body-segment, and in this and the following

[1] 'Quart. Journ. Micr. Sci.,' vol. xlv, N.S., p. 244.

four are borne by conical—dorsal and ventral—processes elevated on pads. The bristles (Plate CIII, fig. 7) are finely iridescent, and form slightly radiate tufts which are fairly conspicuous throughout. Dr. Ashworth observes that in unworn specimens minute spikes occur on the distal third. These have not been observed in spirit-preparations. The next nine or ten are similar in structure, but the pads are smaller. As indicated by Ashworth, the delicate tips of these have minute spines. In addition, a series of furcate bristles (Plate CIII, fig. 7 *b*) occur in each foot, but they scarcely project beyond the surface. The shafts of these taper a little toward the tip, the bristle enlarging below

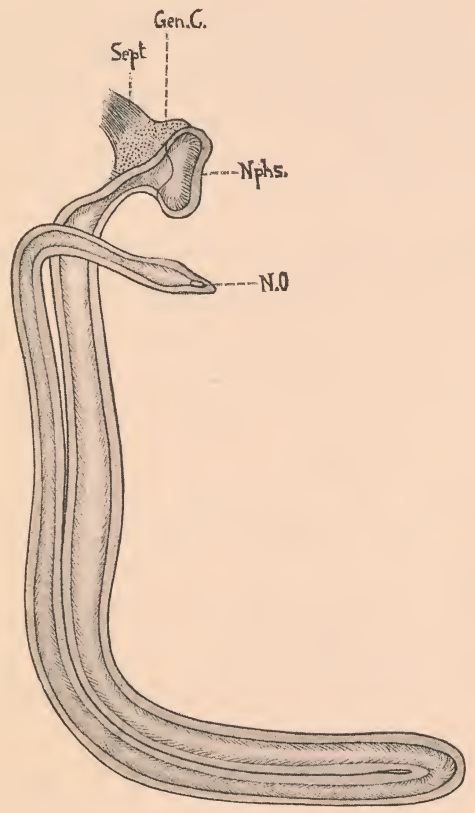

Fig. 104.—Segmental organ of *Scalibregma inflatum*, H. Rathke, after Dr. Ashworth. *Gen. C.* Genital cells. *N. O.* Nephridiopore. *Nphs.* Nephrostome. *Sept.* Septum.

the fork, the limbs of which are unequal. Moreover, the inner edge of each of the prongs is densely spinous.

The dorsal and ventral divisions of the feet toward the posterior part of the region just noted show a tendency to the development of a cirrus, so that about the fifteenth or sixteenth foot a dorsal and a ventral cirrus are evident. These gradually increase in size until, in the posterior region, they form evident lobate lamellæ (Plate LXXXVIII, figs. 4 and Text-fig. 101), somewhat lanceolate in outline, and having the setigerous process at the inner base of each—that is, below the dorsal and above the ventral. In some preparations, notably in one from Lochmaddy, the dorsal and ventral cirri are unusually elongate. The specimen, however, was fragmentary. Toward the tail the feet diminish, and appear to be absent from the last three or four segments.

The cirri are furnished, as Rathke showed, with a series of glands which in the

preparations sometimes give a darker hue to the organs posteriorly. A careful description of these structures has been given, with figures, by Ashworth.[1] The cells are chiefly occupied by bundles of fine rods, but a nucleus is also present. They open on the surface, and are similar to the bacilliparus follicles of other annelids.

The nephridia (Fig. 104) are in the form of slender tubes bent on themselves, with small funnels. The funnels of the first three are situated on the anterior faces of the second, third, and fourth diaphragms respectively. They extend throughout the body. The nephridiopore of the first is just below and slightly anterior to the ventral division of the fourth foot (Ashworth).

Reproduction.—The gonads are very small and are described by Ashworth as present on a thin sheet of tissue (probably representing a septum) between the nephrostome and the body-wall. He could not distinguish the sex, however, until the cells had been shed into the cœlom and increased in size.

Young examples appear sometimes to be devoid of gills (Ashworth's Irish example, 1909).

This was one of the many additions to the Norwegian Fauna made by the acuteness and patient industry of H. Rathke (1843), who gave an accurate description with excellent figures of this interesting species. Amongst other points he compared the glandular structures in the dorsal and ventral cirri to those on the dorsal edge of the foot in *Nereis Dumerilii*. The coloration of his examples seems to have been less vivid than that of the Hebridean forms, which were also larger.

Kölliker in 1864 pointed out the identity of *Scalibregma inflatum*, Rathke, and *Oligobranchus roseus*, Sars. His specimens were yellowish, not reddish like those found in the Outer Hebrides.

Danielssen thought that this species was hermaphrodite, but as De St. Joseph[2] and Ashworth observe this is a misapprehension. Danielssen noticed ova escape by a rupture of the body-wall. Such an occurrence may be associated with the pelagic condition assumed by the forms described by Ditlevsen.

Wirén (1887) gives an account of the anatomy of this species along with other (4) limivorous polychæts. His section of the body-wall is only diagrammatically outlined.

An able account of the anatomy of this form, with excellent figures, is also given by Ashworth.[3] He found Coccidian parasites imbedded in the cells of the loop of the segmental organ.

Ditlevsen[4] (1912) had an opportunity of examining recently between twenty and thirty examples from the Danish expedition to Greenland, and they agreed with Michaelsen's variety *corethrura*, the bristles being extremely long, silky and soft. The most interesting fact noted by this author is that these and many other examples were found in September in a pelagic condition frozen in the ice at the surface (and dead), or swimming in a hole with broken ice and water, and with their reproductive elements in full perfection. The author is thus warranted in suggesting that Michaelsen's variety

[1] 'Quart. Journ. Micr. Sci.,' vol. xlv, N.S., p. 248, pl. xiii, f. 8—11.

[2] 'Ann. Sci. nat.,' 8e sér., xvii, p. 111.

[3] 'Quart. Journ. Micr. Sci.,' vol. xlv, N.S., p. 237, pls. 13—15.

[4] 'Danmark Eksped. Grönl.,' 1906–8, Bd. v, p. 423, pl. xxvii, figs. 7, 8, 9; pl. xxx, fig. 21.

corethrura is the epitokous form of the sedentary *Scalibregma*, in which, both in the ordinary and epitokous condition, he found some pigment-spots in a straight row on the upper side of the dorsal cirri. His largest example was 85 mm. in length, or about 10 mm. more than the fine Hebridean specimen. Michaelsen does not indicate the condition of the reproductive elements.

An orange or yellowish fragment of a *Scalibregma* procured between tide-marks, Lochmaddy, August, 1865, represents the tip of the tail, which is terminated by a distinct dorsal anus, and below it are a pair of anal cirri, the bases of which are close together, that is, each springs close to the middle line, and in the preparation are comparatively short, slightly clavate and curled upward at the tip, but of course this condition may partly be due to the preservative fluid. The foot on this terminal region of the body has a considerable and thick dorsal cirrus and a shorter ventral cirrus, with a small conical elevation between them bearing open bristles, which are furcate, one of the limbs being much longer than the other. No simple bristles are visible.

Certain differences thus exist between this fragment and *Scalibregma*, though the thick cirri had coloured cells internally, and on the whole approached it. The two cirri may be new developments, the parts having been injured.

Genus LXXXVII—Eumenia *Œrsted*, 1843 (including Lipobranchius).

Head bilobed, with a short lateral tentacle on each side. *Body* short, sub-fusiform or maggot-shaped. Segments three-ringed. No anal cirri.

Subramose gills present or absent. Feet represented by two isolated, bluntly conical papillæ, bearing the capillary and furcate bristles. No cirri.

Œrsted (1843–4) thought that this genus made an easy transition from the Ariciæ to the Telethusæ (Arenicolidæ), and it formed one of the genera of his Ariciæ lumbricinæ.

De Quatrefages (1865) instituted a new genus for *E. crassa*, viz. *Polyphysia*, to indicate the varied relationships of this form. He did so on the ground that *Eumenia* had been used by Risso for a genus pertaining to the Phyllodocidæ.

1. Eumenia crassa, *Œrsted*, 1843. Plate CIII, figs. 5 and 5 *a*—bristles.

Specific Characters.—Head conical with two lateral processes or tentacles. Body about 2 in. long, rounded, somewhat fusiform, thickest anteriorly, slightly tapered posteriorly. First six bristled segments bear branchiæ each in the form of a thick cluster of filaments springing from a central stem and in front of the foot, which (foot) consists of a lanceolate lamella dorsally and ventrally, and a fan of simple and forked bristles, the feet being continued from end to end.

Synonyms.

1843. *Eumenia crassa*, Œrsted. Annul. Danic. Consp., p. 47.
1844. „ „ idem. Arch. f. Naturges., Bd. x. p. 111, Tab. iii, figs. 17—20.

1844. *Eumenia crassa,* Œrsted. Region. Mar., p. 78.
1851. „ „ Grube. Fam. Annel., p. 71.
1857. „ „ Sars. Nyt Mag. f. Naturvid., vii, p. 391.
„ „ „ idem. Ibid., xii, p. 303.
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 120.
1861. „ „ Sars. Nyt Mag. f. Naturvid., xii, p. 302.
1863. „ „ idem. Indberet. acad. Kongl. Fred. Universit., p. 51.
1865. „ „ Johnston. Cat. Worms Brit. Mus., p. 221.
„ *Polyphysia crassa,* De Quatrefages. Annel., t. ii, p. 268.
1867. *Eumenia crassa,* Wirén. Köngl. svenska Vet. Akad. Handl., Bd. xxii, text, and Taf. i, figs. 4—11; Taf. ii, figs. 12 and 13; Taf. iii, figs. 5, 12, 16, 17; Taf. iv, figs. 2—5; Taf. 5, fig. 7, 8.
„ „ „ Malmgren. Annul. Polych., p. 76 (sep. copy).
1873. „ „ Sars. Bidrag Christ. Fauna, p. 45.
„ „ „ idem. Nyt Mag. f. Naturvid., xix, p. 245.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 125.
1879. „ „ Tauber. Annul. Danica, p. 109.
„ „ „ Théel. Kongl. svenska Vet. Akad. Handl., Bd. xvi, p. 49.
1883. „ „ Levinsen. Vidensk. Middel. Foren. Kjöbenh., p. 131.
„ „ „ Wirén. Chætop, "Vega" Exped., p. 406.
1887. „ „ idem. Köngl. svenska Vet. Akad. Handl., Bd. xxii, ubique (Anat.), pls. i, iii, iv and v.
1888. „ „ Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 655, pl. xlii, fig. 18 A.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 109.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 138.

Habitat.—Not uncommon in the stomachs of haddocks, St. Andrews (E. McIntosh); Firth of Forth (Cunningham and Ramage). Extends to England (Staples, Brit. Mus.).

Abroad it occurs in Norway and Sweden, as well as in Greenland and Spitzbergen—generally on muddy ground; Atlantic Coast, United States of America (Verrill).

Head conical with two lateral processes or tentacles.

Body thickest anteriorly. First six bristled segments provided with branchiæ—each in the form of a thick cluster of filaments springing from a central stem, and situated in front of the foot. Anal segment devoid of processes, and in the spirit-preparations a prolapse of the region as a crenate trumpet-shaped projection occasionally occurs.

The anterior foot (Plate XCV, fig. 13) consists of a lanceolate lamella dorsally and ventrally and a fan of bristles in each (Plate CIII, figs. 5 and 5 *a*), and the feet extend almost from end to end.

The twentieth foot (Plate XCV, fig. 13 *a*) differs from the anterior chiefly in the greater proportional length and the diminished number of the bristles.

Dr. Johnston[1] (1865) described a specimen procured by Lieut. Thomas at the Staples. He thought it ought to be associated with the Opheliidæ rather than with the Arenicolidæ and Ariciidæ as Œrsted suggested.

[1] 'Cat. Worms Brit. Mus.,' p. 221.

The anatomy of this species was given by Wirén (1887) in his account of the structure of the limivorous polychætes.

2. Eumenia (Lipobranchius) Jeffreysii, *McIntosh*, 1869. Plate XCV, figs. 6 and 6 *a*—body: Plate CIII, fig. 5 *b*—bristle.

Specific Characters.—Head with two short thick tentacles. Body about an inch and a half in length, somewhat fusiform, the greatest diameter being about the anterior third. Rugose tesselated skin as in *Scalibregma* and *Eumenia crassa*. No trace of gills. Foot represented by two simple bluntly-conical papillæ, bearing finely tapered capillary bristles with shorter furcate forms. Anus surrounded by short papillæ. Ventral surface marked by a median groove, which occasionally has a thickened band in the centre. Tubicolous.

Synonyms.

1869. *Eumenia Jeffreysii*, McIntosh. Rep. Brit. Assoc. for 1868, p. 337.
„ „ „ idem. Trans. Roy. Soc. Edinb., vol. xxv, p. 419, pl. xvi, fig. 5.
1888. *Lipobranchius Jeffreysii*, Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 655, pl. xlii, fig. 19.
1894. „ „ De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 103.
1896. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 334.
1908. *Eumenia* (*Lipobranchius*) *Jeffreysii*, McIntosh. Ann. Nat. Hist., ser. 8, vol. i, p. 380.
1909. *Lipobranchius Jeffreysii*, Ashworth. Fisheries Ireland Sc. Invest., 1908, ii, p. 3.

Habitat.—Off the Hebrides in a lengthy tube, 1866, and off Shetland, 1867 (Dr. Gwyn Jeffreys). Firth of Clyde, where it lives in a thick tube of mud and secretions (Cunningham and Ramage). Abroad it occurs off Norway (Canon Norman).

Head small, furnished with two short thick tentacles, which give it a bilobed aspect, and in the preparations it is generally retracted within the papillose anterior region. In retraction the peristomial segment forms a papillose frill encircling the head dorsally. The mouth opens on the ventral surface just behind the snout, and the papillæ are somewhat symmetrically arranged around it, two prominent—one on each side of the middle line—occurring in front, and two in a similar position posteriorly, the rest diverging obliquely from the transverse slit of the mouth in contraction.

Body (in spirit, Plate XCV, fig. 6) of about thirty segments, an inch and a half in length, somewhat fusiform in outline, the greatest diameter being at the anterior third. The structure of the skin and the arrangement of the rugose annulations resemble the same parts in *Travisia*, *Scalibregma*, *Eumenia crassa*, and their allies, but it differs essentially from each of the foregoing in having no trace of branchial filament or appendage. Each segment has three rings, which present the corrugated and tesselated surface, a condition especially evident anteriorly and posteriorly, but probably general in life. The body diminishes a little posteriorly, and then more abruptly in front of the anus, which is terminal and surrounded by a series of short papillæ. The ventral surface is marked by a median groove, which sometimes has a thickened band in the centre.

The feet are represented by a double row of isolated papillæ which run on each side

from the snout to the tail, the summit of each process giving exit to a fascicle of bristles composed of two kinds, viz. numerous long, simple hair-like bristles tapering to a very fine point, and a shorter bifid series (Plate CIII, fig. 5 *b*). The foot-papillæ are smaller in front, and they are rudimentary on approaching the vent, whilst the anal and the first segment are devoid of them.

This is the *Eumenia ebranchiata* of Dr. Baird in the British Museum.

Théel figures a papilla (1879, Pl. III, fig. 46^{20}) between the dorsal and ventral divisions of the foot of *Eumenia longisetosa*, and Ashworth thinks this is a sense-organ.

De St. Joseph[1] (1894) found a small form at Dinard, on the shores of France, which he described as a new species, viz. *Lipobranchius intermedius*.[2] It resembled *Sclerocheilus minutus* in size, and it would appear to have stout, simple, curved bristles in the second segment, and the author thinks it an intermediate form.

Genus LXXXVIII.—Sclerocheilus, *Grube*, 1863.

Head small, prolonged into a short tentacle on each side anteriorly, and close behind are broad ocular bands which meet in front so as to form an angle ∧. On each side posteriorly is a retractile nuchal organ. Body vermiform, elongate, rounded and somewhat fusiform. Buccal segment achætous. Second segment with five or six large spine-like bristles (besides "petites entremêlées," De St. Joseph) between the dorsal and ventral lobes, which have capillary bristles. From the lobes of the other segments proceed both long simple capillary and shorter bifurcate bristles. Small lanceolate ventral cirri only on the posterior segments. Tail terminated by four cirri.

Grube (1863) in his generic description thought the ocular bands were horny processes of the mouth, and not eyes.

De Quatrefages (1865) simply followed Grube's description, and thus continued the misapprehension regarding the ocular bands.

1. Sclerocheilus minutus, *Grube*, 1863. Plate CIII, figs. 8—8*b*—bristles; Plate XCVII, fig. 1—hook; Plate XCVI, fig. 15—hooks; Plate C, fig. 3—bristles.

Specific characters.—Head with two well-marked short tentacles and two brownish-red ocular bands on each side, which by union in front form an acute angle. Body dull brick-red, three quarters of an inch long, segments about 40—50, like *Scalibregma* in outline and in skin, but the resplendent bristles are longer, and there is a series of foot-lobes, which form shorter cones anteriorly, longer cones posteriorly. A ventral cirrus from the twenty-second foot backward, which, at its longest, is about a third the diameter of the body. From the second segment a transverse fascicle of strong bristles with gently curved and tapered tips projects on each side. The feet elsewhere have rather long simple golden iridescent bristles, and at their bases are the tips of a series of bifid forms, one limb of the fork being longer than the other. Posteriorly are four or five slender anal cirri.

[1] 'Ann. Sc. nat.,' 7e sér., t. xvii, p. 113, pl. v, figs. 146–147.

[2] As this passes through the press Mr. Southern records this species (*Asclerocheilus intermedius*) from the Clare Island district. 'Proc. Roy. Irish Acad.,' vol. xxxi, pt. 47, p. 137.

Synonyms.

1863.	*Sclerocheilus minutus,*	Grube.	Arch. f. Naturges., Bd. 29, p. 50, Taf. v, fig. 3.
1864.	,,	,,	idem. Die Insel Lussin, p. 85.
1865.	,,	,,	De Quatrefages. Annel., t. ii, p. 280.
1869.	,,	,,	Grube. Abhandl. Schles. Gesell., 1868—69, p. 127.
,,	,,	,,	idem. Mitt. St. Vaast, p. 37.
,,	,,	,,	idem. Jahresb. Schles. Gesell., p. 41.
1875.	,,	,,	Marion and Bobretzky. Ann. Sc. nat., 6me sér., t. ii, p. 86.
1879.	,.	,,	idem. Ibid., t. viii, p. 5.
1885.	,	,,	Carus. Fauna Medit., p. 251.
1894.	,,	,,	De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 104, pl. v, fig. 126—145.
1904.	,,	,,	Journ. M. B. A., vol. vii, p. 231.
1908.	,,	,,	McIntosh. Ann. Nat. Hist., 8 ser., vol. i, p. 380.
1914.	,,	,,	Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 137.

Habitat.—Procured in a trammel-net off Fermain Bay, Guernsey. The net had touched the ground and entangled an old valve of *Pecten opercularis* richly covered with various growths. Also under stones between tide-marks, Herm, 1868. Plymouth (Allen). Clare Island (Southern). Abroad it has been found at Lussin Piccolo, Crivizza, Cigale, Neresine, on the Adriatic (Grube). Shores of France, Dinard (De St. Joseph). St. Vaast (Grube). Marseilles (Marion).

Head furnished with two well-marked though not long tentacles, and two brownish-red ocular bands which form an acute angle by union in front.

Body about three quarters of an inch long, segments 40–50, somewhat fusiform, and resembling a small *Scalibregma*, slightly tapered anteriorly and more so posteriorly, the surface being minutely tesselated and marked by transverse furrows. It is flanked by rather long tufts of pale resplendent bristles and a series of short foot-lobes. Posteriorly it terminates in an anal segment provided with five slender cirri. The body has a uniform dull brick-red colour, or very pale brownish-red, more deeply tinted here and there on the dorsum from the blood-vessel. The cœlomic bodies are pale. The mouth opens on the under surface of the peristomial segment in the form of a broad $\wedge$ in the spirit-preparations, the angle directed forward. De St. Joseph describes the proboscis as a rounded, unarmed, muscular process larger than the head and ciliated internally, and it is followed by a short pharynx, a dilated œsophagus, a stomach, and a ciliated intestine which shows folds and pouches and contains air and water, so that the author thinks the posterior region respiratory. He considers that the circulation is lacunar, the spaces uniting here and there to form vessels, though some spaces are always isolated. At the eighth or ninth segment they constitute a dorsal vessel which becomes bifid at the third segment, and the two trunks form the ventral. Branches from the ventral go transversely to the feet and the intestine, the latter twigs communicating with the lacunæ on the walls of the gut. The ventral vessel is lost in lacunæ posteriorly.

Feet.—The first segment is achætous. The second has dorsally a foot-papilla bearing simple bristles, ventrally a papilla holding a series of five or six stout simple bristles finely tapered at the curved tip (Plate CIII, fig. 8 *a*), though sometimes more or

less abraded. De St. Joseph associates these with the making of its galleries in the shells, just as in the case of the powerful hooks on the fifth segment of *Polydora*. Their function, whatever it may be, is certainly important, and they are moved by special muscles. They are brownish by transmitted light, and have no longitudinal striæ.

The next and the succeeding segments have the simple curved bristles (Plate CIII, fig. 8), of a fine pale-golden sheen, passing from the dorsal and ventral papillæ, which vary somewhat in appearance in the different parts of the body, forming shorter cones in front, longer cones posteriorly. At the base of these bristles, and just projecting beyond the skin in the preparations, are a series of bifid forms (Plate CIII, fig. 8 *b*), one limb of the fork being longer than the other, and the inner edge of both limbs is spinous. About the twenty-second segment a slender cirrus, approaching a third the diameter of the body at its longest, appears below the ventral papilla. According to De St. Joseph, its tip is furnished with palpocils in life.

This is a southern type so far as the present examples go, but it may yet occur on the western shores. Its small size and obscure habits may have led to its being overlooked, yet when captured the animal is lively, boring actively with its snout amongst the mud.

A post-larval *Sclerocheilus*, measuring 4 or 5 mm. in length, was dredged in 1868 off Sark by Col. the Hon. A. Fraser and Capt. Powell. Anteriorly are four black eyes, and on each side of the broad anterior region are three of the strong hooked bristles characteristic of the species. They point forward.

The body, which at first sight resembled that of a young *Spio*, is widest at the end of the anterior third, from which it is slightly tapered to the broad snout, while posteriorly it gradually diminishes to the tail, which ends in two short processes and a cirrus, but the former may be doubled cirri. The bristled segments appear to be between thirty and forty. The second segment bearing the hooks has in addition several long, tapering, slightly curved bristles (Plate XCVI, fig. 15). The succeeding segments have larger and stronger tufts of these bristles (Plate CIII, fig. 8, and Plate C, fig. 3), which, though slightly curved, stand stiffly out, so as to give the form a hirsute appearance. On the other hand, the bristles of the posterior half slope backward in the preparation, though in life their position might be as prominent as the foregoing. Moreover, at the base of each tuft are minute bifid forms with unequal limbs to the fork (Plate CIII, fig. 8*b*). This is probably a young stage of the foregoing.

Grube (1863), who discovered this form, apparently mistook the dorsal surface for the ventral, and thus thought the ocular bands horny processes of the mouth. His description is otherwise accurate.

Sclerocheilus was placed by De Quatrefages (1865) at the end of the Opheliidæ of uncertain position, for to him it had the appearance of an *Ammotrypane* without branchiæ, and yet the large bristles of the second segment approached those of *Polydora*.

A careful account was given in 1894 by De St. Joseph, who corrected Grube's interpretation of the eyes as a horny band, and added considerably to our knowledge of its structure and its relationships. He computed the segments at fifty-four or more, described bacilliparus follicles in the hypoderm, and gave three rings to each segment.

Some of the eyes have lenses. A retractile and ciliated nuchal organ occurs on each side as in *Capitella* and *Polyophthalmus*. After a general description of the annelid, he concludes that it resembles the Spionidæ in its head, the Capitellidæ and Opheliidæ in the vibratile nuchal organs, and *Polydora* and *Disoma* in its great anterior bristles. But it truly pertains to the Scalibregmidæ, for the posterior region is slender and terminates in delicate cirri, the proboscis is round and short, the foot has two setigerous lobes with simple and bifid bristles, and the surface of the body is tesselated. It differs in the absence of branchiæ.

De St. Joseph describes the segmental organs as present in all the segments, except the first seven and the last twelve. The outer part consists of a brownish canal ciliated internally, curved on itself, and which debouches ventrally on a papilla at the base of the lobe of the foot. Internally it is translucent, forms an angle with the coloured part, and ends in a ciliated funnel which he describes as fixed to the wall of the body, though he probably refers to the homologue of a dissepiment. He considered the organs excretory, and that they likewise act the part of gonaducts.

The curious form, *Nevaya Whiteavesi*, McIntosh,[1] dredged in the Gulf of St. Lawrence by Dr. Whiteaves, bears powerful hooks on the second foot, which probably is connected with the habits of the annelid, as in *Sclerocheilus*.

Family XVII.—Sphærodoridæ, *Malmgren*.

Cephalic region conical, with short papillæ and four eyes. Proboscis smooth. Body somewhat like that of a Nematelminth, but with numerous segments, each uniramous foot having a conspicuous globular papilla. Anal segment with a papilla on each side.

In transverse section the body-wall (Fig. 105) has externally a firm transparent cuticle which is raised into numerous papillæ (*p*) with a central process of hypoderm which does not seem in the preparations to reach the surface, though it may have done so in life. Beneath is a very thin layer of hypoderm, the largest mass being in the mid-ventral line below, *i. e.* external to the nerve-trunks, and it separates the ventral longitudinal muscles, which form a thin belt on each side up to the origin of the oblique muscles. The dorsal longitudinal muscles are also rather thin. The nerve-cords are separate, appearing in front as two flattened cords, and in the middle as two rounded masses in section above the hypodermic area and separated from it by a stratum of neuroglia. The trunks fuse at the ganglia. The slender oblique muscles touch their exterior and are inserted into the basement-tissue beneath them.

In sections of the anterior end the proboscis, when drawn in, has a dense sheath of longitudinal fibres, then a thick circular layer, within which are the basement-tissue and the densely papillose lining. In the middle of the body the digestive canal forms in section an ovoid granular structure, and posteriorly it is voluminously folded. Whilst in some the cœlom is filled with large granular cells (*gs.*), in others large rounded ova with a tough and minutely papillose capsule occurred in the anterior sections and perhaps represent ripe eggs, the capsule resembling that in certain Spionids.

[1] 'Ann. Nat. Hist.,' ser. 8, vol. vii, p. 149, etc.

When a large globular papilla is included in the section glandular hypoderm fills the interior, and it has a smaller papilla distally.

Ephesia and *Sphærodorum* were both entered by Grube (1851) as genera under his Ariciea, along with the Spionidæ and Cirratulidæ somewhat after the arrangement of Audouin and Milne Edwards.

De Quatrefages (1865) considered the *Ephesia* of Rathke most nearly approached the Syllidæ, and hence he appended it and allied forms to that group. He did not observe that the *Pollicita* of Johnston, the *Ephesia* of Rathke, and the *Sphærodorum* of Œrsted referred to the same type.

The Sphærodoridæ formed the sixth family of Levinsen's[1] *Syllidiformia vera*, the Nerillidæ separating them from the Syllidæ. In the structure of the bristles—both

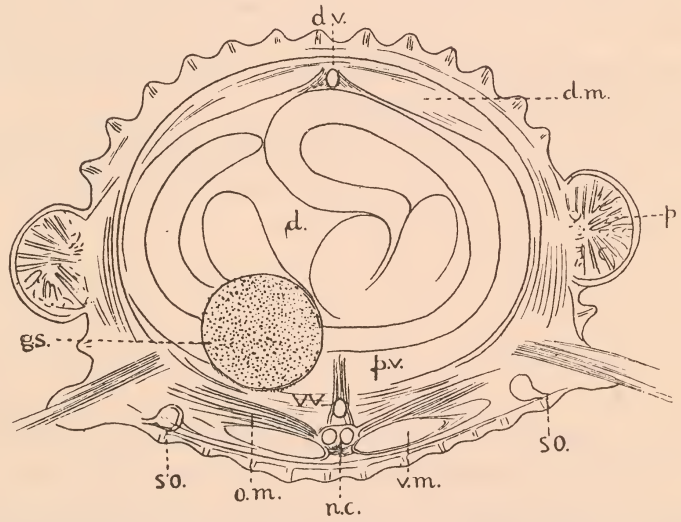

Fig. 105.—Transverse section of the anterior third of *Ephesia gracilis*, H. Rathke. *d.* Modified dorsal cirrus. *gs.* Large granular ovum.

simple and compound—they certainly approach the Syllidæ, and even in other respects the relationship is noteworthy.

In Benham's[2] (1896) classification the Sphærodoridæ were the 11th family of the Nereidiformia and placed between the Glyceridæ and the Ariciidæ, yet he observes that the family, though much modified, is allied in some respects to the Syllidæ.

Considerable confusion existed in regard to the species in this family from the earlier records of Œrsted and Rathke to those of Greef and Levinsen, the latter correctly, however, separating *Ephesia* from *Sphærodorum*, a view emphasised by De St. Joseph and Perrier. Perrier again divided the family into three genera, viz. *Ephesia*, Rathke, ex. *E. peripatus*, *Hypephesia*, Perrier, ex. *H. gracilis*, St. Joseph, and *Sphærodum*, Œrsted, ex. *S. Claparedei*. He was followed by Moore who gave new names to the three species. In Britain the two forms are readily distinguished. The family has a wide distribution, stretching from the North Sea and the Atlantic to the centre of the Pacific and again to the Antarctic seas.[3]

[1] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 180.

[2] 'Camb. Nat. Hist.,' vol. ii, p. 320.

[3] 'Mém. Soc. Zool. de France,' pp. 1—94, text-figs.

Genus LXXXIX.—Ephesia, *Rathke*,[1] 1843.

Sphærodorum, Œrsted; *Berbyce*, Thompson; *Pollicita*, Johnston.

Head bluntly rounded, with numerous papillæ; four minute eye-specks. Mouth inferior. Body elongated, slightly narrowed anteriorly and more distinctly posteriorly, where it ends in a small rounded tip with a globular papilla on each side. Segments about 120. Surface with numerous small papillæ, and a series of larger globular papillæ on the feet dorsally. Bristles simple, with tips like a bill-hook or with a jointed tip, as in *Autolytus*. Proboscis elongate, clavate, smooth. Nerve-cords separate. Segmental organs normal. Ova circular, large, with minutely dotted capsule.

Ephesia (his *Sphærodorum*) was included by Œrsted[2] under the family Ariceæ, the sub-division Ariciæ nereidæ, and the eighth genus. His main characters were the linear rounded body, numerous papillæ in place of tentacles along the entire margin of the head; eyes four; in place of branchiæ a series of globular processes with a terminal papilla and with minute papillæ between them; uniramous feet; tail with two globular cirri. He thought it a transition-form between the Ariceidæ and Nereidæ (especially the Glyceridæ). The globular processes contain vermiform bodies, but are not ovaries.

Levinsen (1883) made two genera of the Sphærodoridæ, viz., *Ephesia*, Rathke, and *Sphærodorum* (*non* Œrsted), the latter having six processes on the head instead of two.

Carus (1885) omitted, probably from an oversight, this family from his 'Prodromus Faunæ Mediterraneæ.'

1. Ephesia gracilis, *H. Rathke*, 1843. Plate LXXXVIII, fig. 10; Plate XCV, fig. 9—posterior end; Plate CIII, fig. 9—bristle.

Specific Characters.—Head bluntly rounded, with papillæ on the free border, a median and two lateral being longer; four minute eye-specks, the anterior pair nearer each other. Mouth opening immediately behind the tip of the snout. Body reaching $2\frac{1}{2}$ inches, elongate, segments about 120, tapering a little anteriorly and more distinctly posteriorly, where it ends in a small rounded tip with a large globular papilla on each side. Lateral papillæ commence behind the snout, increase in size to the middle of the body, and again diminish posteriorly. Thinly distributed, small papillæ in rows occur on the general surface. Colour,[3] straw-yellow in front, rest pale brown or dull reddish-brown, the hues being darker over the intestine, and some have a faint lilac or purplish tint in the centre. Foot has dorsally the opaque, whitish, globular process, then the setigerous lobe hispid with papillæ at the extremity, and bearing a spine and simple bristles with the tip in the form of a bill-hook.

Synonyms.

1843. *Ephesia gracilis*, Rathke. Fauna Norweg., Nova Acta Acad. Leop.-Car., xx, 1, p. 176, Tab. vii, figs. 5—8.
1843. *Sphærodorum flavum*, Œrsted. Annul. Dan. Consp., p. 43, f. 7, 92, 101.
1844. „ „ idem. Arch. f. Naturges., Bd. x, p. 108.

[1] Rathke named the form after Diana of Ephesus.

[2] 'Arch. f. Naturges.,' Bd. x, p. 108, 1844.

[3] The coloured figure was taken from a specimen in which *post-mortem* changes had occurred.

1851. *Ephesia gracilis,* Grube. Fam. Annel., pp. 67 and 133.
„ *Sphærodorum flavum,* idem. Ibid., pp. 67 and 134.
1853. *Nereis bullata,* Dalyell. Pow. Creat., ii, p. 147, pl. xxii, figs. 1—5.
1865. *Ephesia gracilis,* Johnston. Cat. Worms Brit. Mus., p. 206.
„ *Pollicita perpatus,* Carrington. Proc. Lit. and Philos. Soc. Manch., iv, p. 7.
1867. *Ephesia gracilis,* Malmgren. Annul. Polych., p. 190.
1868. „ „ Sars. Christ. Vid.-Selsk. Forhandl., p. 10.
1873. „ „ idem. Nyt Mag. f. Naturvid., xix, p. 242.
„ „ „ De Quatrefages. Annel., t. ii, p. 84.
„ *Sphærodorum flavum,* idem. Ibid., p. 85.
„ *Ephesia gracilis,* Sars. Bidr. Christ. Fauna, p. 47.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 24.
„ „ „ McIntosh. Invert. and Fishes St. Andrews, p. 125.
1879. „ „ Tauber. Annul. Danica, p. 110.
„ „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 51.
1881. „ „ Leslie and Herdman. Proc. Roy. Phys. Soc. Edinb., vol. vi, p. 67
1883. „ „ Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 93.
1886. „ „ Marenzeller. Internat. Polarforsch., p. 14 (Jan Meyen).
1894. „ „ De St. Joseph. Ann. Sc. nat., 7^{e} sér., t. xvii, p. 38, pl. iii, figs. 51–54.
„ „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 92.
1898. „ „ De St. Joseph. Ann. Sc. nat., 8^{e} sér., t. v, p. 345.
„ „ „ Michaelsen. Grönländ Annel., p. 126.
1904. „ „ Journ. M. B. A., vol. vii, p. 227.
1908. „ „ McIntosh. Ann. Nat. Hist., 8 sér., vol. ii, p. 528.
„ „ „ Ehlers. Deutsch. Tiefsee-Exped., p. 106.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 61.
1911. „ „ Ruderman. Mém. Soc. Zool. Paris, t. 24, pp. 1–96, pl. i.
1912. „ „ Crawshay. Journ. M. B. A., vol. ix, p. 343.
1913. „ „ Augener. Zool. Anzeig., Bd. xli, p. 261.
„ „ „ Ehlers. Deutsch. Sudp. Exped., p. 504.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 88.

Habitat.—The coralline region (Johnston). Occasionally, in fissures of sandstone rocks, between tide-marks; not uncommon in the *débris* of the fishing boats, and tossed on the West Sands, St. Andrews, after storms (E. McIntosh); dredged in six fathoms, on muddy ground, Lochmaddy; in seven fathoms amongst old bivalve shells, Bressay Sound; and on sandy ground, amongst tangle-roots, in the Sound of Harris (W. C. M.). The finest examples came from the deep water off St. Andrews Bay; Millport, Cumbræ (Kölliker); Hebrides (Claparède); Lamlash Bay, Arran (Dr. Howden); trawlers' boats, Elie, Fife, 1863 (R. McIntosh); St. Peter Port, Guernsey (W. C. M.); Birturbury Bay, Ireland; Berehaven (R. I. A.), Clare Island district (Southern); Plymouth (Crawshay).

Cosmopolitan—from pole to pole. South Pole (Ehlers). Norway (Rathke and Malmgren). Examples of good size dredged by Canon Norman off Bergen, Norway; Finmark, Spitzbergen, Greenland, Sweden; 300 fathoms off Norway (Sars); Western shores of France (De St. Joseph); Atlantic Coast, U.S.A. (Verrill); Franz-Joseph Land (Augener).

Head (which is often invaginated) bluntly rounded, the free border having numerous

papillæ some of which are longer, viz. a median and two lateral, which are held to be of the nature of tentacles; two superior and two inferior tentacles, the two pairs being separated from each other by three long papillæ; eyes four, two on the second and two on the fourth segment (De St. Joseph, 1894). A little in front of a line drawn between the centre of the third pair of globular processes are four minute eye-specks, the anterior pair being the closer. They disappear in many spirit-preparations. No special definition of the region occurs posteriorly, the first globular processes, which are small, are close behind.

Body (Plate LXXXVIII, fig. 10), ranging from $2\frac{1}{2}$ inches downward, slender, elongate, tapering gradually toward each extremity, but more distinctly posteriorly, the tail being considerably smaller than the head. The mouth opens on the ventral surface immediately behind the tip of the snout, and a somewhat clavate, smooth, muscular proboscis occasionally projects. The number of segments would seem to vary, the large example of more than $2\frac{1}{2}$ in., having about 120 bristled segments. The lateral papillæ commence as small organs immediately behind the snout and gradually increase in size till the average is reached in the middle of the body. They remain nearly of similar size till the caudal narrowing takes place when they again diminish, and they become much smaller as well as nearer each other toward the tip of the tail, which ends in a small rounded extremity with a larger globular papilla on each side, as large, indeed, as the seventh from the tip. The contrast is thus pronounced. The entire surface of the body is studded with thinly distributed papillæ which form transverse rows, about three occurring between each globular process. Such gives an appearance of fine transverse striæ, of which there are three or four in each segment. Each papilla is conical, having externally the translucent cuticle, and a central axis of hypoderm. A few of the papillæ are larger, and possess a basal process from which the clavate terminal part projects.

The anterior part of the body is of a straw-colour for a short distance, the rest being of a pale brown or dull reddish brown, the hues being darker over the intestinal region posteriorly. Some have a faint lilac or purplish hue in the centre in July. The globose tubercles are of an opaque yellowish white throughout.

The foot consists dorsally of the opaque white globular process which appears to be a modification of a cirrus. It is smooth throughout, and has at its outer and upper surface a clavate papilla similar to those on the surface of the body. In Rathke's figure this is much larger than in nature. The conical setigerous lobe occurs beneath, and its surface and tip are hispid with large papillæ like those which appear on the surface of the body. It is supported by a single strong, translucent, tapered spine, which has a tip either simply pointed or bevelled. De St. Joseph observed a nerve-twig enter the sphere and pass to the terminal papilla. The bristles (Plate CIII, fig. 9) have nearly cylindrical straight shafts when seen on edge, only slightly tapered at the knife-like tip. When viewed laterally the shaft gently increases in diameter from the base distally, and has a backward curve below the tip which has the shape of a bill-hook, viz. a broad dilatation at the base and a sharp, curved hook distally. The number of the bristles is usually four in the typical process.

It is probable that in some cases the authors have not sufficiently studied the

distinctions between *E. gracilis* and *E. peripatus*, and that the entry of some of the synonyms may be open to criticism.

Habits.—It crawls with moderate activity, and occasionally twists itself in screw-coils. It probably lives in crevices of shells and similar places and often on a muddy bottom. A young form (*S. Greeffi*) was found by Giard as a commensal of *Ophiocoma neglecta* at Wimereux.[1] It was also dredged in the 'Porcupine' at the considerable depth of 1214 mètres.

Reproduction.—Females were laden with large ova in July.

Young examples about 6 mm. long, but with numerous segments, occurred in the bottom-net off the Bell Rock in August, along with numerous young Polynoids.

Ehlers describes a pelagic young form with thirteen bristled segments from the Antarctic Sea. The body at this stage forms a long ellipse.

H. Rathke (1843), in describing in his 'Fauna Norwegens' this form for the first time, considered that it approached *Goniada* under the family of the Nereids. His description and figures are, on the whole, good, though his examples were small, viz. ten lines. His drawing of the posterior end, however, is imperfect, and the papilla on the tip of each "mamilla" is too large, but he gave a correct outline of the type of bristle. He did not notice the eye-specks.

Œrsted (1843) constituted the genus *Sphærodorum* for this species—his *S. flavum*—very shortly after Rathke's announcement. His description is satisfactory so far as it goes.

In his sketch of the classification of the Polychæta, Grube (1851) entered this form under two names, viz. *Ephesia gracilis* and *Sphærodorum flavum*, placing them between *Polydora* and *Aonis*.

Dalyell (1853) evidently refers to this species as *Nereis bullata*, his description and figures leaving no room for doubt: though the enlarged figure is too dark in colour, and thus differs from his description "universally yellow."

Kölliker (1864) in his 'Kurzer Bericht' described the coiled glands of the dorsal papillæ, and he pointed out that the ovoid swellings of Claparède on the nerve-cords were the ganglia themselves.

Dr. Johnston (1865) entered this form in his catalogue of the worms in the British Museum between the Ariciidæ and the Cirratulidæ. He retained Rathke's generic title, but used *Sphærodorum* for his *S. peripatus*.

A full account of the anatomy of this species has recently been given by Ruderman[2] (1911) with illustrative figures in the text. The minute structure of the glands and segmental organs received careful attention.

2. Ephesia peripatus, *Claparède*, 1863. Plate CIII, fig. 10—bristle.

Specific Characters.—Head with two pairs of slender tentacles slightly clavate at the tip, a series of minute papillæ occurring between them Eyes four, on the second segment; anterior pair with lenses. Body about two inches long. It terminates in two globular dorsal cirri and an unpaired ventral cirrus beneath (Claparède). Foot with a globular

[1] 'Bull. Sc. France et Belgique,' 1890, p. 60; and Giard. 'Œuvres Diverses,' 1913, p. 56.

[2] 'Mém. Soc. Zool. France,' t. xxiv, pp. 1—96, 1 pl.

dorsal cirrus; and a ventral cirrus, which in the third and fourth segments has papillæ on the enlarged base. Bristles with jointed tips.

Synonyms.

1845. *Pollicita peripatus,* Johnston. Ann. Nat. Hist., vol. xvi, p. 4, Tab. ii, fig. 1—6.
1851. *Sphærodorum peripatus,* Grube. Fam. Annel., pp. 67 and 134.
1856. *Pollicita* „ Thompson. Fauna Ireland, vol. iv, p. 434.
1863. *Sphærodorum* „ Claparède. Beobacht., p. 50, Taf. xi, fig. 8—18.
1864. „ „ Kölliker. Kurzer Bericht., p. 9, Taf. vi, fig. 1.
1865. „ „ Johnston. Cat. Worms Brit. Mus., p. 208.
„ *Pollicita* „ De Quatrefages. Annel., t. ii, p. 85.
1894. *Ephesia* „ De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 41.
„ ? „ *abyssorum,* Bidenkap. Christ. Vid.-Selsk. Forhandl. (after Hansen), p. 93.
1908. „ *peripatus,* McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 529 and 540.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 61.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 89.

Habitat.—The Clyde area (Kölliker); Channel Islands (W. C. M.); Torquay (Elwes); Clare Island district (Southern).

Gulf of St. Lawrence, Canada, dredged by Dr. Whiteaves.

Head similar to that of *E. gracilis,* with four tentacles, and it is often retracted. The two lateral globular cirri with short papillæ.

Body resembles that of the common species, and is about two inches in length, somewhat spindle-shaped, and terminating posteriorly in two globular papillæ with the anus between, and an unpaired ventral cirrus inferiorly (Claparède).

The foot presents dorsally a globular cirrus with a papilla at the extremity, and near its base a gland with coiled contents. The setigerous region forms a cone with small papillæ thinly scattered over its distal region, and a larger process or cirrus ventrally below the tip. Anteriorly the base of this process is hirsute and a longer papilla occurs at the tip of the setigerous process (third and fourth segments).

The bristles are more slender than those of *E. gracilis,* but the distal end of the shaft has a similar curvature. The bevelled end is much less produced, and the enlarged region on the whole more nearly approaches that of a Syllid. Moreover there is an articulated appendage which starts from a broad base and has a sharp hook-like tip, the curvature dorsally being convex and ventrally concave (Plate CIII, fig. 10). Such a bristle differs from the long, hook-like tip of the shaft in *E. gracilis,* which theoretically might be supposed to arise after the shedding of the terminal process, by the free growth of the end as a hook-like structure.

A detailed account of this form, which he clearly differentiated from *Ephesia gracilis,* was given by Claparède in 1863 with figures. He showed the simple nature of the alimentary apparatus, for after the folded œsophagus the stomach formed an ovoid enlargement, and the intestine ran straight from this to the vent. The peculiar and forwardly directed ganglia of the ventral chain have not been seen in the sections of the northern forms. The author likewise gave an account of the contents of the globular dorsal cirri and the glands in the foot beneath them. He pointed out that Œrsted's association of the genus with the Ariciidæ could not hold, nor that of Johnston with the Goniadidæ. He was inclined to link it on to the Syllidæ.

Sphærodorum abyssorum Hansen,[1] a species from the Norwegian Northern Expedition, has jointed bristles like the present species. The head is slightly hollowed in the middle, with a rounded process at each side, but the foot differs from the southern form just described.[2]

Family XVIII.—Telethusæ, *Savigny*, 1820 (Arenicolidæ).

Arenicolea, Audouin and Milne Edwards; Paromocrisea, De Blainville; Dorsalées, Lamarck; Arenicoliens, De Quatrefages.

Limivorous forms in which the head is moderately developed, devoid of appendages, and bounded posteriorly by the nuchal grooves. No palps or tentacles. Eyes indistinct. A pair of statocysts (otocysts) as a rule in the first segment (except in *A. Claparedii*).

The body is elongate, rounded, of three regions, with numerous pairs of branched gills which are absent from the first six segments. It ends in a somewhat blunt anal extremity. Four annuli occur between each setigerous ring, except in the first three or

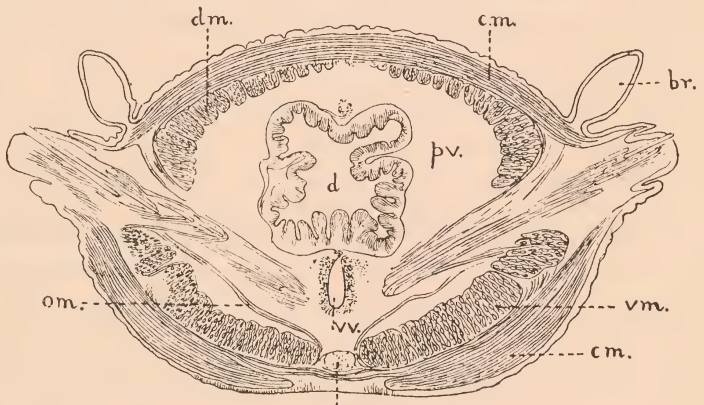

Fig. 106.—Transverse section of *Arenicola marina*, L. *br.* Branchia. *cm.* Circular muscular fibres.

four segments. Pharynx globular, unarmed, though the papillæ may have a cap of chitin. The feet are sessile and little developed, the dorsal division bearing capillary bristles, and the ventral, which forms a thickened pad, having a vertical row of long hooks.

Nerve-cord non-ganglionated.

Three diaphragms occur in the cœlom at the anterior end of the first, third, and fourth segments. A pair of hearts place the gastric vessel in connection with the ventral.

Segmental organs five, six, or thirteen pairs, the first pair opening on the fourth or fifth segment.

One or more pairs of glandular cœca at the posterior part of the œsophagus. No cœlomic septa in region of stomach, but strong septa are present at the anterior part of the first, third, and fourth bristled segments, and in the intestinal region.

Externally the body-wall in the anterior (pre-branchial) region has a thin cuticle covering the glandular hypoderm beneath. The circular muscular coat which follows is of considerable strength, and anteriorly often presents thicker parts in transverse sections. Within is the powerful layer of longitudinal muscle forming various wedge-shaped masses

[1] 'Nyt Mag. f. Naturvid.,' Bd. xxiv, p. 9, Taf. vi, figs. 9—12, 1879.

[2] Mr. Southern has recorded the occurrence of *Sphærodorum Claparèdii*, Greeff, and *S. minutum*, Webster and Benedict, from Blacksod Bay, July, 1914.

of fasciculi, the dorsal and ventral muscles being clearly defined. The condition of the musculature of the body-wall depends much on the preparation, for those with flaccid, distended bodies present very different appearances from those in a vigorously contracted condition. The former have a series of isolated muscular fasciculi inside the body-wall, whilst in the latter the longitudinal muscles form more or less compact sheets. The former taper dorsally, and are thickest a little above their lower end.

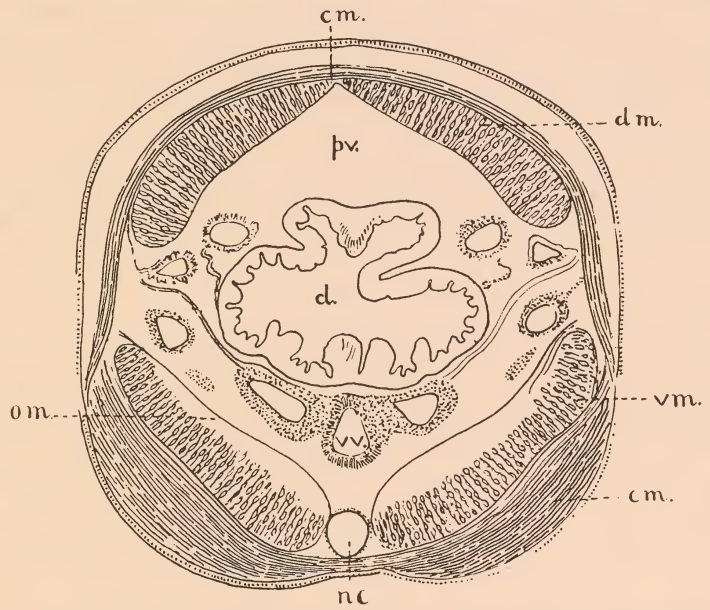

Fig. 107.—Transverse section of *Arenicola marina*, L., behind the foregoing (106).

The ventral longitudinal muscles are nearly of the same breadth throughout in section, and have the origin of the oblique muscle as a boundary above, and the nerve-cords in the mid-ventral line.

Anteriorly in *A. marina* the nerve-cords which, though apparently single externally, are double on section, lie in the mid-ventral region between the ventral longitudinal muscles,

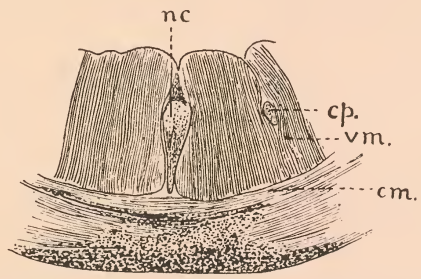

Fig. 108.—Ventral wall of *Arenicola marina*, L., in contraction over nerve-cord, and with a Coccidian parasite (*cp.*) in the muscle.

and form an ovoid area with a neural canal superiorly. Externally are the neurilemma, hypoderm, and cuticle. The slender oblique muscles pass to their outer border for insertion or fusion with the circular. The alimentary canal has a thin external investment, a few circular fibres, and numerous minute chloragogenous cells, which stain deeply on its exterior. Within is a thick glandular layer which is thrown into numerous folds. The blood-vessels along the gut have a thick coat of the glandular (chloragogenous) tissue. The dorsal vessel has a much thinner coat of these cells than the others. Great

differences, however, exist in the appearances of the parts in preparations, apparently from the methods adopted.[1] When sections pass through the heart-bodies, their structure is as described by Dr. Ashworth.[2]

In transverse section of a rigidly contracted example the nerve-cords are pyriform, the elongated stalk bifurcating as it approaches the circular muscular coat and the fibres enter it. These nerve-cords have been thrust inward by the close approximation of the ventral longitudinal muscles, and the neurilemma has been elongated into a stalk, a condition which might mislead during a cursory examination.[3] Cunningham states that a small neural canal occurs at the dorsal and inner side of each cord. The pyriform nerve-area is partly divided by a granular band from the stalk. The inner edge of the great longitudinal muscles is covered by a distinct sarcolemma. Traces of an oblique muscle appear between the second muscular wedge of the longitudinal layer and that above it. A fissure occurs in the mid-dorsal line, where the longitudinal coat is thinner, and on each side muscular wedges (in section) occur above the traces of the oblique. In the anterior region the œsophagus has a thin investment, probably of both circular and longitudinal fibres, and its mucous surface is richly glandular. The œsophageal sacs or glands have a thin wall of similar structure, but their mucous lining forms deep folds, which in transverse section present a somewhat pinnate appearance from the cells and their nuclei.

In transverse sections of the posterior region of *A. marina* toward the tip of the tail, the circular muscular layer is proportionally strong, and the longitudinal muscles of considerable thickness. The nerve-area has the same position—inside the circular muscular coat, but the trunks are more distinct than in front. The neural canal is still at the upper border, and, indeed, separates the nerve-cords superiorly, and they often present a slight obliquity—that is, they are slightly tilted outward superiorly. Externally is a thick layer of neuroglia, the cells of which stain deeply, and pass upward between the cords like a wedge, then nerve-sheath, basement tissue, hypoderm, and cuticle. The oblique muscles go to the upper and outer angle of the nerve-area, and a few fibres pass down its side to reach the circular. The gut is wide, but agrees in structure with that in front. No apparent differentiation of the cords into ganglionic or inter-ganglionic regions occurs either here or in front.

In *Arenicola ecaudata* the nerve-trunks are thrust further inward than in *A. marina*, but the oblique muscles preserve the same relations. A single neural canal occurs at the centre superiorly, in the anterior region, but by-and-by two larger canals appear. On the whole the cords in section are more pyriform than in *A. marina*, and are fixed by neurilemma to the circular muscular layer. The cells of the neuroglia form two bands inferiorly, a space existing between them. In a preparation of Dr. Ashworth's the sperm-cells occur in great lobular masses in the cœlom.

In *Arenicola branchialis* the arrangement of the layers of the body-wall is typical, and the outline of the nerve-trunks in section conforms rather to that in *A. marina* than in *A. ecaudata*, the shape being ovoid, with a mass of neuroglia inferiorly and strands of

[1] 'Quart. Journ. Micr. Sci.,' vol. xxviii, N.S., p. 273.

[2] 'L. M. B. C. Memoirs,' xi, p. 35, pl. v.

[3] I am indebted to Dr. J. H. Ashworth for kindly sending slides of the sections of *A. marina*, *A. branchialis*, and *A. ecaudata* for comparison with my own, some of which were made by the hand.

neurilemma. A single neural canal occurs in the median line just within the neurilemma in the anterior part of the body. As in other forms the nerves leave the lateral part of the cords, and slope downward to the muscular layer. Posteriorly the nerve-trunks are less rounded, the long diameter being vertical, but the single neural canal persists superiorly.

Though the family was first constituted by Savigny under the title of Telethusæ, yet in accordance with the rules adopted in other cases the term Arenicolidæ suggested by Audouin and Milne Edwards is perhaps more appropriate.

Montagu[1] (1808) figures "*Arenicola ceruleata*" with only seven pairs of branchiæ and a tail. It is probably an abnormal specimen. His *Lumbricus congesticia* is also an *Arenicola*.

Cuvier (1817) placed the genus *Arenicola* at the head of the Dorsibranchs, and thought that five blackish patches anteriorly represented the testicles, the eggs swimming in the interior of the body.

The Telethusæ formed the second family of De Blainville's (1828) second order Paromocriciens, a group containing a heterogeneous series from *Amphinome* to *Marphysa*.

This group formed the tenth family (Arenicoliens) of Audouin and Milne Edwards (1834), who thought they linked the errant to the sedentary annelids, mentioning that Savigny ranged them amongst the Serpulidæ, whilst Cuvier placed them with the Dorsibranchs.

Grube (1851) adopted Savigny's title Telethusa for this family, under which he also included *Dasybranchus* (his *Dasymallus*) now grouped with Capitellidæ.

De Quatrefages[2] (1850) agrees with the description of the circulation given by Milne Edwards, and adds that ventrally the vessels pass upward on the gut and form a series of cæca having the aspect of villosities on the chloragogenous coat.

This author[3] states that the cephalic mass in *A. marina* is single, and gives off only a nerve on each side to the auditory organ (described by Stannius). The œsophageal connectives are slender, and the only representative of a visceral nerve is a small twig which leaves the connective of each side immediately after its commencement. The ventral cord is single with ganglionic enlargements in each segment from which the lateral trunks pass.

The same author at a later period (1865) gives a brief historical summary pointing out how the lob-worms were at first confounded with the earth-worms; then Lamarck separated them as a genus, and Savigny made the family Telethusæ; subsequently Audouin and Milne Edwards called the group Arenicoliens. De Quatrefages outlines the general structure of the family and notes the presence of an auditory organ (statocyst). He arranges the genera according to the sequence of the branchiæ, *Arenicola* having these organs in sequence, whereas *Chorizobranchia* has them separated by non-branchial feet. Ashworth has shown that considerable confusion occurred in the early diagnosis of the species of *Arenicola* in the Museum at Paris.

Kinberg[4] (1866) gave his Telethusea no special position, for they occur after the

[1] M.S. vol. Libr. Linn. Soc., 4to, pl. xxviii, fig. 2.

[2] Types Infr. de l'embranchement des Annelés, 'Ann. Sc. nat.,' 3e sér., t. xiv, p. 283, etc.

[3] Ibid., p. 366 (sep. copy).

[4] 'Öfversigt K. Vet. Akad. Förhandl.,' p. 355.

Subellidæ and before the Hirudinacea. He recognized the distinction of *A. Loveni* of the Cape from the European forms.

Levinsen[1] (1883) grouped the Telethusæ with the Scalibregmidæ under the Arenicolina, a natural arrangement for both families.

V. Carus (1885) places the Arenicolidæ between the Scalibregmidæ and Maldanidæ, but adds nothing to previous knowledge.

Viallanes[2] (1885) treats of the endothelium of *Arenicola*, which he considers protective, and points out that it passes into that covering the muscular fasciculi, and over the diaphragm.

An elaborate paper was written by Ehlers[3] (1892) on the auditory organs of *Arenicola marina*, *A. Claparedii*, *A. Grubii*, and others—accompanied by excellent figures. In the case of *A. marina* the organ opens to the exterior and the otoliths are foreign particles. In the other two species no duct exists, and the otocysts or statoliths are secreted by the sac itself.

The Arenicolidæ constituted the third family of Prof. Benham's[4] (1896) third suborder—Scoleciformia of the order Nereidiformia.

Fauvel[5] (1899) gave an interesting historical account of the "Arénicoliens" with critical remarks, a description of their external morphology, cœlom, alimentary, circulatory, and nervous systems, segmental organs, reproduction, habitat, geographical distribution, relations to *Branchiomaldane*, and phylogeny and affinities—illustrated by text-figures. In this paper he holds *Branchiomoldane* to be only a synonym for the young of *Arenicola*. Fauvel, like Claparède, thought *A. ecaudata* the most primitive form, and *A. Claparedii* he placed at the head of the series on account of its prostomial lobes, its cephalic ganglia, the development of its sensitive palps, and its digestive system. He disagreed with Mesnil's view that the Arenicolidæ and Maldanidæ are closely related and might be combined.

Ashworth[6] has given a full and excellently illustrated description of *Arenicola*. He thinks that the family has certain affinities with the Scalibregmidæ and Opheliidæ since they have a spacious cœlom subdivided anteriorly by diaphragms, an eversible pharynx, followed by an œsophagus with one or more pairs of lateral glandular outgrowths, a dilated stomach, more or less freely movable, and a straight intestine, usually with a ventral groove. Yet, after comparing the organs in each, he concludes that they are clearly distinguished from these and the Maldanidæ.

In his recent account of the Arenicolidæ in the Museum at Berlin[7] he places reliance in diagnosis on the number of the chætiferous and branchiferous segments, the structure of the branchiæ, the relative size of the median and lateral lobes of the prostomium, the absence or presence of the openings of the statocysts, the position of the nephridial pores,

[1] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 180.
[2] 'Ann. Sc. nat.,' 6e sér., t. xx, p. 20, 1 pl.
[3] 'Zeitschr. f. wiss. Zool.,' Bd. liii, Suppl. p. 219, pls. xi–xiv.
[4] 'Camb. Nat. Hist.,' vol. ii, p. 333.
[5] 'Mém. Soc. nationale Sc. nat. et Mathém. Cherbourg,' t. xxi, pp. 101—186.
[6] 'L. M. B. C. Memoirs,' xi, Arenicola, 1904.
[7] 'Mitt. Zool. Mus. in Berlin,' Bd. iv, p. 148, 1910.

and the development of the ventral division of the foot in the anterior three or four, as well as in the last three or four bristled segments. He places little reliance on the structure of the hooks and bristles in distinguishing the species. He also examined those in the Museum at Paris.[1]

The development of *Arenicola Claparedii*, as subsequently stated, has been described by Dr. Ashworth[2] from the ripe ova onward to the fourteenth day when only three pairs of bristles were present. The larva had two eyes, and complete alimentary canal.

Bohn[3] (1903) describes, with the aid of two text-figures, the galleries of *Arenicola* on the beach, viz. perpendicular, sloped, and curved, and their condition in aquaria, where the tubes often have but a single aperture. The galleries of *Arenicola Vincenti*, again, occur under *Lithothamnion*, and it is a more sedentary form; whereas *A. Grubei* and *A. ecaudata* wander considerably, the latter occasionally coming to the surface surrounded by mucus and swimming freely, as Ferronière[4] found in *Cirratulus filiformis*, which, like *Arenicola*, shows geotropism in its tunnels, those in dry sand being vertical, those in wet sand being horizontal. The author also alludes to the varieties of *Arenicola marina* at sexual maturity.

Bresil[5] (1903) examined the secretion of the œsophageal glands of *Arenicola*, and found that these in an alkaline medium rapidly dissolved albuminous substances like trypsin.

Lillie[6] (1905) gave an account of the development of the nephridia in *A. cristeta*. Amongst other features he considers the first setigerous segment as the second body-somite. He traced the nephridium from undifferentiated cells of the mesoblast through an early stage where the ciliated tubule opens anteriorly into the body-cavity, but not yet externally, to the fully developed organ with its blood-vessels, nephrostome, and terminal vesicle. They differ, therefore, from the organs of the young lava of *Phoronis*, in which, as outgrowths of the nephridial pit, they are wholly of ectodermal origin.[7]

The statocysts or otocysts of this group have received much attention since their discovery by Grube, Stannius, and Siebold, and their careful description by Ehlers, Jourdan, Ashworth, and Gamble. One of the most recent researches on the subject is that of Prof. Fauvel,[8] who locates the otocysts in the peristomium of *A. marina*, and gives sections of the region in this and other species of *Arenicola*. He sums up by observing that two species are devoid of otocysts, viz. *Arenicola Vincenti* and *A. Claparedii*. In two species the otocysts communicate with the exterior by a ciliated canal, whilst the otocysts themselves have no cilia. The otoliths consist of grains of quartz from the exterior, but by-and-by are covered by a secretion, the species being *A. marina* and *A. assimilis*. In one species, viz. *A. cristata*, the closed otocysts contain a single large otolith

[1] 'Ann. Sc. nat.,' 9e sér., t. x, p. 111.

[2] Arenicola, 'Liverpool Marine Biol. Committee,' p. 52, pl. viii, 1904. *Vide* Dr. Child, 'Archiv für Entwickelung-mechanik. der Organismen,' Bd. ix (*A. cristata*); E. B. Wilson, 'Studies Biol. Lab. Johns Hopkins Univ.,' ii, 1883, pp. 271—299.

[3] 'Bull. Mus. Paris,' 1903, p. 62.

[4] 'These Faculté des Sc. de Paris,' 1901.

[5] 'Archiv. Zool. expér., 4 sér., t. i, p. 6.

[6] 'Mitt. Zool. St. Neapel.,' Bd. xvii, p. 341, pls. 22—25.

[7] Cresswell Shearer, idem, Bd. xvii, p. 487, pls. 31—33.

[8] 'Ann. Sc. nat.,' 9e sér., t. vi, p. 27.

secreted by the cyst. In *Arenicola Grubei* and *A. ecaudata* the closed otocysts are devoid of vibratile cilia, and contain one large otolith and several smaller—all secreted by the otocyst, and only having Brownian movements. In all the species the otocysts (in the peristomium) are innervated from the œsophageal collar.

Downing (1911)[1] observes that in *Arenicola cristata* the spermatophore arises as the result of cleavage of a primary spermatogonium. It is shed into the cœlom even before the cleavage of the spermatogonium has begun, becoming a hollow mass of cells which by false invagination becomes gastrula-like, then flattens out—a saucer-like mass of spermatids. He suggests that the spermatophore is an individual, the gametozoon, which bears the gametes; the adult male is a sporozoon, which develops the spore or primary spermatogonia; and he holds that it is a kind of alternation of generations.

The Arenicolidæ were entirely absent from the collections of the 'Challenger,' and this of itself more or less defines the distribution of the group to comparatively shallow water.

Sub-Family I.—Arenicolidæ caudata, *Ashworth.*

Head (prostomium) has a median and two lateral lobes; brain with distinct anterior, middle, and posterior regions. Body often enlarged anteriorly. Feet and gills do not extend to the posterior end—leaving a distinct tail. Gills pinnate or derivable therefrom, eleven to thirteen pairs, the first (which may be small or absent) on the seventh or eighth setigerous segment. Dorsal lip of segmental funnel (nephrostome) with numerous, flattened, spathulate, ciliated, branched vascular processes; ventral lip ciliated, entire. Gonads small, ova discoidal; thin zona. Segmental organs six pairs in segments four to nine, or five pairs in segments five to nine.

Genus XC.—Arenicola, *Lamarck*, 1801, *char. emend.*

Lumbricus, Linnæus; *Chorizobranchus*, De Quatrefages; *Clymenides*, Claparède.

Cephalic lobe small, conical, with a single palpode, or provided with two rudimentary palps, often with statocysts. Black granular pigment in the hypoderm (epiderm, Fauvel); anterior diaphragms; post-buccal segments two and three uncinigerous; pair of œsophageal cœca; two lateral hearts each formed of auricle and ventricle. Branchial segments of five annuli; gills much branched, borne on the setigerous ring, fixed to the dorsum. Dorsal division of the feet tubercular, arising anteriorly at the inferior face of the stomachal sinus, posteriorly of the dorsal vessel. Inferior division of the foot forming a torus. Dicœcious: gonads borne only on the segmental organs.

Fauvel (1899) groups the forms specially considered here thus: No achætous abranchiate caudal region; eleven to twelve uncinigerous abranchiate segments—*A. branchialis* (*Grubii*); fifteen to sixteen uncinigerous abranchiate segments—*A. ecaudata*. Prostomium of three sub-equal lobes, first pair of branchiæ small—*A. marina*. The same author[2]

[1] 'Science,' vol. xxxiii, p. 272.

[2] 'Compt. Rend. Acad. Sc.,' Paris, t. cxxix, p. 1273, 1899.

describes the different pigments of the group, viz. a yellow lipochrome and a black pigment, and he thinks the latter may be a modification of the former.

After an exhaustive inquiry into the anatomy of the Arenicolidæ, Gamble and Ashworth (1905) find that the genus *Arenicola* may be divided into two sections, the first including *A. marina*, *A. Claparedii*, and *A. cristata*, characterised by a well-marked prostomium, a well-developed brain with anterior and posterior cerebral lobes, the presence of six pairs of nephridia in segments four to nine, or five pairs in segments five to nine, and the absence of gills and feet in the posterior region. The second section comprises *A. branchialis* and *A. ecaudata*, with simple conical non-lobate prostomium and commisural brain, and the continuation of the gills and setigerous sacs to the tip of the tail.

Ashworth (1912) includes *Branchiomaldane* in this family, and points out its distinction from *Arenicola*, such as the presence of only two rings in each branchial segment instead of five as in *Arenicola*. The nephridia are two on each side, and the form is hermaphrodite, with large ova.

1. Arenicola marina, *Linnæus*, 1758. Plate LXXXVIII, figs. 5, 6, and 7; Plate XCIV, fig. 2—young; Plate CIII, figs. 11–11 *d*—bristles.

Specific Characters.—Prostomium three-lobed, the lateral sometimes exceeding the median in size. Statocysts communicating with the exterior. Statoliths formed of numerous foreign bodies, *e.g.* sand-grains, which may be coated with a chitinoid investment. Nineteen setigerous segments. Thirteen pairs of gills; the first, on the seventh segment (sixth bristled segment), may be reduced or suppressed. The dorsal divisions of the foot in the posterior branchial region are dorso-ventral and near the middle line. Six pairs of segmental organs on segments 4—9, the first being in the third bristled segment. One pair of œsophageal pouches, cylindrical, club-shaped, or conical. One pair of smaller, globular, or flask-shaped muscular pouches on the first diaphragm. Colour greenish-brown, or velvety-greenish black, and iridescent. The Neapolitan examples are rose-red and transparent. Tail a third the length of the body (Carus). Many small specimens procured amongst sand near low-water mark are pale greenish-yellow with red vessels and branchiæ. The anterior and posterior ends are darker. Post-larval forms are known by the open statocyst with foreign statoliths, a single pair of œsophageal pouches, and the small pair of segmental organs in the third setigerous segment. Larval forms are polytrochus.

Synonyms.

1553. *Lumbricus marinus,* Belon. Hist. Poiss., p. 444.
1602. *Lugg,* Carew. Survey Cornwall, p. 346.
1638. *Lumbricus marinus,* Aldrovandus. De Iuvert., lib. 7, p. 734.
1684. *Vermis ex arena effosus Lug dictus,* Sibbald. Scotia Illust. II, pars 3, p. 34.
1710. *Eruca marina,* Sibbald. Hist. Fife and Kinross, p. 56.
1710. *Vermes marini Scolopendroides Cornubiensibus Lugs dicti,* Ray. Hist. Insect., p. 46.
1746. *Lumbricus punctis prominulis,* Linnæus. Fauna Suec., p. 364, No. 1270.
1751. *Orm,* idem. Skånska Resa, p. 315.
1754. *Lumbricus punctis prominulis,* idem. Mus. Adolph Frid., p. 92.

1758. *Lumbricus marinus,* Linnæus. Syst. Nat., ed. 10, vol. i, p. 648.
1761. „ „ idem. Fauna Suec., 2nd Edit., p. 504.
1767. „ „ idem. Syst. Nat., ed. 12, vol. i, p. 1077.
1769. „ *punctus prominulis,* idem. Amœnitates Acad. VII, p. 483.
1775. „ *littoralis,* Olafsen et Povelsen. Reise durch Island, ii, p. 478, taf. v, fig. 8.
1776. „ *marinus,* O. F. Müller. Prodr. Zool. Danica, p. 215, No. 2609.
1777. „ „ Pennant. Brit. Zool., ed. 3, IV, p. 34, pl. xix, f. 7, and ed. 4 (1812), IV, p. 64, pl. 20.
1779. *Ver du Havre,* Dicquemare. Obs. sur la Physique, Rozier, xiii, p. 19, pl. ii.
„ *Lumbricus marinus,* J. C. Fabricius. Reise Norweg., p. 257.
1780. „ „ O. Fabricius. Fauna Grönl., p. 279, No. 262.
„ „ *papillosus,* idem. Ibid., p. 283, No. 267.
1783. „ *marinus,* Barbut. Genera Verm., p. 13, Tab. i, fig. 4 (reprint by Bosc, t. i, pl. vi, fig. 3).
1788. *Nereis lumbricoides,* Pallas. Nova Acta Acad. Petrop., t. ii, p. 233, Tab. 5, figs. 19 and 19*.
1791. *Lumbricus marinus,* Gmelin. Linn. Syst. Nat., ed. 13, vol. i, pt. 6, p. 3084.
„ „ „ Bruguière. Vers, Encycl. Meth., p. 102, tab. 34, fig. 16.
1797. „ „ Duméril. Bull. Soc. Philom. Paris, t. i, p. 114.
1799. „ „ J. Rathke. Skr. Naturh. Selsk. Kjöbenhavn, v, p. 76, Tab. 2, f. 6 A—B.
1801. „ „ Stewart. Elements, II, p. 354.
„ *Arenicola piscatorum,* Lamarck. Syst. Anim. sans Vert., p. 324.
1802. *Lumbricus marinus,* Olafsen et Povelsen. Voy. Isl., p. 139.
„ „ „ Turton's Linnæus, IV, p. 58.
„ *Arenicola carbonaria,* Bosc. Hist. Nat. Vers, t. i, p. 161, pl. vi, fig. 3.
1806. *Lumbricus marinus,* J. Rathke. Müller's Zool. Danica, iv, p. 39, pl. 155, figs. 1—5.
1807. „ „ Turton. Brit. Fauna, p. 128.
1816. *Arenicola tinctoria,* Leach. Encyclop. Brit., Suppl. to eds. 4—6, vol. i, p. 452.
„ „ *carbonaria,* idem. Ibid., p. 452, pl. 26.
1817. „ *marinus,* Oken. Isis, p. 469, taf. iii.
„ „ *clavata,* Ranzani. Opusc. Sc., ii, p. 110, tab. iv.
„ „ „ idem. Isis, pp. 1449—1459, taf. xi.
„ *Arénicole des pêcheurs,* Cuvier. Règne Anim., ii, p. 527.
„ *Lumbricus marinus,* Home. Phil. Trans., p. 1, pl. iii, figs. 1—3.
1818. *Arenicola piscatorum,* Lamarck. Hist. Anim. s. Vert., v., p. 336.
1820. „ „ Savigny. Syst. Annel., p. 96.
„ „ *carbonaria,* idem. Ibid., p. 97.
„ „ *clavatus,* Ranzani. Mem. d. St. Nat., i, p. 8, pl. i, fig. 1.
1823. *Lumbricus marinus,* Home. Comp. Anat., iv, pl. xl, figs. 1—3.
1826. *Arenicola marina,* Payraudeau. Annel., etc., de Corse, p. 18.
1827. *Lumbricus marinus,* Delle Chiaje. Mem. Anim. s. Vert. Nap., ii, pp. 423, 429.
1828. „ *piscatorum,* De Blainville. Dict. Sc. Nat., t. lvii, p. 479, pl. iv, fig. 1.
„ „ *carbonaria,* idem. Ibid., t. lvii, p. 447, Atlas, pl. vi, fig. 1.
„ *Arenicola piscatorum,* Stark. Elem. nat. Hist., vol. ii, p. 135.
1829. *Common Lug,* Drummond. Loud. Mag. Nat. Hist., ii, p. 124.
1830. *Arénicole des pêcheurs,* Cuvier. Règne Anim., ed. 2, t. iii, p. 198.
1833. *Arenicola piscatorum,* Audouin and Edwards. Ann. Sc. nat., t. xxx, p. 420, Tab. xxii, figs. 8—12.
1834. „ „ idem. Hist. nat. Litt. France, t. ii (Annel.), p. 285, Tab. viii, figs. 8—12.
„ *Lumbricus marinus,* Roget. Anim. and Veg. Physiol., i, p. 277, f. 135.
1835. „ „ Sars. Beskriv., p. 47.
„ *Arenicola piscatorum.* Edin. Journ. Nat. and Geogr. Sc., iii, p. 245.

1835. *Arenicola piscatorum,* Fleming. Encycl. Brit., edit. 7, xi, p. 219, pl. 275, fig. 10.
1836. „ *marina,* Templeton. Loud. Mag. Nat. Hist., ix, p. 234.
„ „ „ Johnston. Ibid., viii, p. 567.
1838. „ „ Jones. Anim. Kingd., p. 212.
„ „ *piscatorum,* Milne Edwards. Ann. Sc. nat., sér. 2, t. x, pp. 22, 212—217, pl. xiii, figs. 1 and 1 *a*.
„ „ „ Lamarck. Hist. Anim. s. Vert., 2 ed., v, p. 580.
„ „ „ *partim,* Grube. Anat. Kiemenw., p. i, pl. i.
1840. „ „ *partim,* Grube. Actin. Echin. u. Würmer, p. 66.
„ „ „ Stannius. Müller's Arch. Anat., p. 352.
1841. „ „ Delle Chiaje. Descriz., vol. iii, p. 92.
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Habitat.—Abundant all round the British shores, including Ireland, in sand or muddy sand in U-shaped tubes. Laminarian variety, common on certain parts of the Lancashire coast, *e.g.* near Blackpool, at extreme low water (about 3 ft. in sand); also in the Forth between Portobello and Musselburgh (Ashworth); Jersey, St. Andrews, etc.

Ashworth[1] observes that this species occurs on the western shores of Europe as far south as Portugal, in the north to Norway, White Sea, the west side of Spitzbergen, and the western part of the Baltic. It extends to the Mediterranean (Trieste), and is found in the Faroes, Iceland, Greenland, and along the east coast of America as far as Noank, Connecticut.

The *Head* is trilobate, and generally retracted beyond the crescentic nuchal groove (nuchal organ). It bears no processes, and the eyes (2—5) are only visible on section. Ashworth thinks the first two annuli represent the peristomium, and that the third and

[1] 'Cat. Chætopoda Brit. Mus.,' p. 101, 1912.

fourth annuli represent a segment which has lost its setæ. In the peristomium are the statocysts which communicate with the exterior by a narrow tube opening at the point where the "metastomial groove crosses the interannular groove" (Ashworth). Grube and Stannius thought them appendages of the œsophageal connectives. Siebold, again, first pointed them out as sense-organs, and he was followed by De Quatrefages, Frey, and Leuckart.

The *Body* may be divided into three regions (after Ashworth): (1) an anterior bearing feet, but no gills; (2) a middle region bearing both feet and gills; and (3) a posterior which has neither gills nor bristles. One of the annuli of each segment is larger and generally more prominent than the others and bears the feet, dorsally the conical process carrying the bristles, and dorso-ventrally the rows of hooks on a muscular ridge. The first few rows are small, but by-and-by they almost meet in the mid-ventral line.

There are thirteen branchiferous segments, and in front of the first gill are six setigerous segments. Each has four rings, except between first and second gill, where only two rings occur, and between second and third, where there are two rings (laminarian variety) or three, as in the littoral variety. The second groove behind each setigerous annulus marks the posterior limit of that segment (where the internal septæ are fixed). Ashworth holds that these gills are not developments of dorsal cirri.

Between the first setigerous annulus and the prostomium is a region of four rings, each of the first three of which may again be subdivided into two. This region is composed of peristomium and a body-segment, the setæ of which (a single one, Benham) are minute, and disappear early. The anterior region is the peristomium, and bears the otocysts. The first setigerous segment in the adult is thus the third body-segment. Ashworth is of opinion that the "giant nerve-cells" bear out the foregoing interpretation.

The presence of a vestigial seta in the post-larval forms of *A. marina* and *A. ecaudata* indicates a segment between the peristomium and the first adult setigerous segment (Gamble and Ashworth). This appears to be confirmed by the presence of a single "giant-cell" at the meeting-point of the connectives in this species, in *A. ecaudata*, and in *A. cristata*.

The gills have 9—11 stems, each with 3—5 pairs of short lateral branches (Plate LXXXVII, fig. 6) in the littoral variety. In the laminarian variety (16 in. long) the gill is pinnate, consisting of about twelve stems, united by membrane at their bases, and having ten or more branches on each side of the axis. It differs from the littoral variety also in the subdivision of the interval between the second and third setigerous annuli. In the laminarian it is divided into two rings, in the littoral into three. There is no other structural difference.

Gamble and Ashworth note two types of gill in this form, viz. the dendritic and the large feathered or pinnate. The branches are only connected at their bases by a kind of web. The gills contract from behind forward, and thus assist in the circulation.

The mouth is a crescentic transverse slit, on the antero-ventral aspect of the peristomium, through which the proboscis is protruded. This organ is pinkish in young, darkly pigmented in old examples. The proboscis in extrusion does not appear to differ materially from that of the other British species. Its base has a series of larger papillæ,

which in some assume the form of distinct areolæ, whilst the distal and larger area is covered with smaller conical papillæ, larger papillæ again marking the aperture into the œsophagus. In old specimens the region of the large papillæ at the base is blackish, whilst that of the smaller papillæ is pale greyish-brown. Differences seem to exist as to the extent of the surface covered by the large basal papillæ. Ashworth[1] notes that in examples from Vierville the papillæ of the proboscis were large. The proboscis is followed by the pinkish or greenish-brown œsophagus which pierces the three diaphragms, and just behind the last bears a pair of glands (sacs). Behind is the stomach covered with yellow cells and blood-vessels, and extending to the eleventh or twelfth bristles, after which is the yellowish-brown or dark olive-green intestine which terminates in the vent. The ventral groove of the stomach is ciliated, and this groove extends to the anus. Sand and muddy sand are taken in by the proboscis and mixed with the œsophageal secretion, then it receives the secretion of the two glands, passing on to the stomach. The movement of the canal in this region is thought to favour the thorough mixing of the food and secretion (Ashworth). The ventral groove, moreover, is in close relation to the sub-intestinal vessels, and a thin cord of mucus is seen in fresh sand-casts. The species thus acts as a cleanser of the sand from decomposing matter, for it is generally found only where sand is thus mixed.

The tail is without gills or feet. There may be seventy segments (Ashworth), but the worm has a tendency to throw off the last few segments when irritated, new segments being formed at the anterior end of the tail, where the segments are short, but posteriorly they are longer, some having about ten annuli. Near the posterior limit of each segment in the mid-tail region is an annulus larger and more deeply pigmented than the rest, and apparently corresponding to the setigerous ring in front. A shallow groove occurring in the mid-ventral line marks the position of the nerve-cord.

Nineteen pairs of bristles occur along the sides, and they can be extruded a considerable distance on their papillæ. The first pair is shorter and more slender than the succeeding. In large specimens the bristles are about one-fifth of an inch in length, and they are directed transversely outward. The shaft of these bristles (Plate CIII, figs. 11—11 *a*—*c*) is powerful, flattened, and finely striated. The terminal region of the bristle is distinguished by the slight diminution at the commencement of the wing and it tapers from this point to the tip. The wing (or wings, for two may be present) is narrow, forms a web like the barbs on a feather, though from its structure it readily splits, widens and again diminishes distally. As the bristle lies with the web on one side, the opposite edge has only minute serrations for some distance, whilst the dorsum is smooth. Then this edge becomes more spinous and spikes become evident on the dorsum. Gradually as the wing diminishes in breadth the spikes increase in length and form whorls on the slender tip. Though it may not be easy to distinguish the bristles of *Arenicola marina* from those of foreign species they seem to be readily differentiated from those of *Arenicola branchialis* and *A. ecaudata*—being larger, and with more coarsely spinous tips than either of the two just mentioned.

The bristles represent the dorsal division of the foot, the long hooks the ventral division, and they are coincident with them. The first six tufts show a gradual increase

[1] 'Ann. Sc. nat.,' 9e sér., t. x, p. 112.

in size from before backward; the seventh is decidedly broader than the sixth and the papilla somewhat more prominent. From the eighth backward the papillæ appear to be very prominent and the rows of hooks about equal in breadth; moreover they nearly meet in the middle line. The hooks (Plate CIII, fig. 11 *d*) have a golden colour, a shape somewhat like that of a golf-club with the handle bent back (the basal part of the hook). About the middle of the hook a gradual and slight enlargement occurs with well-marked oblique striation and a series of transverse lines. The oblique striæ pass to the distal curve of the hook, the tip alone being free, and they also proceed downward to the insertion. Two, three, or four minute spines occur on the convex part of the rostrum. Friction seems to render these indistinct and make a blunt tip to the rostrum. The enlarged part of the hook appears to coincide with that bearing the strain at the edge of the ridge into which it is inserted.

Nephridia.—Each consists of a funnel or nephrostome, a secreting portion, and a posterior terminal vesicle or bladder. It is always bright red from its vascular supply. A comparatively recent and excellent account with figures is given by Dr. H. M. Kyle.[1] Gamble and Ashworth[2] place the external opening of these organs behind and at the upper edge of the ventral division.

Ashworth notes the differences presented by the hooks of young forms in which the angle formed by the rostrum is much less than in adults and the secondary spurs on the crown are longer. Moreover a spur occurs beneath the rostrum. In the post-larval *A. marina* there are besides the ordinary bristles one winged form with faint oblique striations on the wings. This caused Mesnil to make a new species (*Clymenides sulfureus*) of this stage. In the post-larval hooks two or three teeth occur behind the beak and a point under the beak. In old specimens no teeth exist above, but the sub-rostral point is present.

At Lochmaddy, North Uist, not only are the ordinary coils of sand abundant in the creeks, but many in hollows are on the summit of considerable mounds of smooth sand, and thus the areas are very rugged. The mounds are probably due to the gentle flow and ebb of the tide, and to the fact that the areas in the creeks referred to are generally surrounded by stones covered with Fuci. The absence of anything like a "run" or rush of the advancing or retiring tide would appear to favour this condition.

Everywhere around the British and European shores this form is employed as bait for codling, plaice, and other fishes. In searching, the men look for the "eye," or anterior hole, a little cup-shaped depression in the sand, at some distance—9—12 in. —from the casts. At St. Andrews the men consider that when the wind blows from the east it is difficult to see the "eye," or anterior hole, as the sand is soaked, but it is otherwise in a west wind. They dig rapidly from the "eye" to the casts, and generally find the anterior end of the worm near the curve of the tube. Lately a different method has been followed, for they actively dig round the cast until the hole is seen. If the work is slowly carried out the worm makes a fresh tunnel in the sand and escapes.

In confinement the worms perish rapidly if left in the collecting vessel, and even when spread out on a board amongst moist sand they survive only for a day or two, *e.g.* from Saturday to Monday, and even then it is considered that they are less effective.

[1] 'Ann. Nat. Hist.,' ser. 6, vol. xviii, p. 295, pls. xiii—xv, 1896.

[2] 'Quart. Journ. Micr. Sci.,' vol. xli, N.S., p. 509, 1899.

A single worm of good size will make bait for four or six hooks, each piece being broken off and fixed on the hook. The fingers appear to suffer much from friction and the secretion in this work, and soon bleed. It has been found that by dipping the fingers in a solution of alum this injury is avoided.

Habits.—The sides of the burrows are stained with the yellowish-green exudation. The sand is ejected from the anus, forming a spiral coil on the surface, and near it is a wide hole, from which the anterior end is protruded when the tide is full, though Dr. Johnston states that it is the posterior end. The worm is usually about a foot below the surface at low water.

Reproduction.—M. Sars (1845) described the grass-green eggs of what he considered to be *Arenicola* enveloped in mucus, and he noticed segmentation and hatching of the young (with red eyes) which he figures. They occurred in February and March at a depth of some feet, adhering to *Zostera* and Fuci. The relationship of these to *Arenicola*, however, is uncertain.

Max Schultze[1] in 1856 detailed the development, prefacing it with a general account of Annelidan growth, yet the roseate gelatinous masses, with a long pedicle of mucus, which he procured at Cuxhaven, appear to belong to *Scaloplos armiger*, or a similar species, the bristles especially differing from those of *Arenicola*.

Cunningham and Ramage (1888) found similar gelatinous cocoons in the Forth in February, the jelly being translucent and the ova and embryos white. As their larvæ had two anal cirri, they thought they pertained to *Scoloplos armiger*. They state that the genital products are shed in the Forth in August and September. They observe that transverse mesenteries are only present in the four anterior somites, and here they are incomplete. A septum occurs between the buccal and the first bristled segment, none between the first and the second bristled segments. One lies behind the second and one behind the third bristled segment.

Hornell (1891) again, describes the large green pear-shaped egg-masses associated with the sandy coils of *Arenicola* on the 2nd of March, the stalk of the cocoon passing 2 or 3 in. into the sand, and he made observations on the development.

The littoral forms breed from the end of February to the end of April, and again from July to September (Ashworth).

The reproductive cells occur immediately behind the posterior portion of the nephrostome, but not on the first pair—thus only five pairs of gonads are present (Gamble and Ashworth).

The genital products escape by the last five pairs of segmental organs, some by the first pair also, and the ova are often caught by the mucus surrounding the worm. The ova are 0·16 mm. in diameter, and have a distinct but thin vitelline membrane (Gamble and Ashworth).

Numerous pale green gelatinous masses about the size of a small gooseberry were found by the fishermen digging for lobworms on the 3rd of May, usually with a long strand of mucus at one end. The eggs appear to have been deposited since the previous day as none were then found, and they are early eggs, being about the thirty-two cell stage. They evidently develop with rapidity. The capsule is firm and elastic. Next day (4th)

[1] *Vide* also a short notice in the 'Zeitschr. f. wiss. Zool.,' Bd. iv, p. 192, 1852.

they were distinctly segmented into a series of large cells. The space between the capsule and the contents was more distinct. On the 6th the embryos were ciliated.

The development of *Arenicola Claparedii* has been carefully followed by Ashworth (1901), the larva rotating in the egg at the twenty-eighth hour after fertilisation, and the stomodæal invagination was present. Twenty-four hours later the telotroch condition was assumed, and one or two red eyes appeared. At the end of the third day the larvæ escaped and were 0·25 mm. long. A broad longitudinal band of cilia now occurred on the ventral surface between the anterior and posterior bands. A bristle or two appeared shortly after hatching, but it was four or five days before hooks were seen. They died about a fortnight after hatching, as soon as the yolk was absorbed, for though the mouth was open they did not feed. Post-larval stages were found at the surface in a gelatinous tube. Specimens of *Arenicola marina*, 3—9 mm. long (mounted), have the full complement of gills and all except the first two have become branched. These had reached the end of the pelagic stage, and would soon have settled on the bottom. Ashworth, however, has seen others 6·5 mm. long without gills, so that there is variety. The smallest specimen found by Ashworth in the sand was 17 mm. in length at the end of June. Young examples are more or less pinkish in colour.

A small form (Plate LXXXVIII, fig. 7) was got in the bottom tow-net 11th May inside a loose membranous sheath, which it by-and-by left. A series (nineteen) of long simple bristles project from the surface anteriorly, whilst posteriorly is the narrower tail terminating in the vent. The colour is gamboge-yellow anteriorly and posteriorly, the rest, pale buff. Behind the proboscidian region a section (stomach) of the canal was boldly barred by transverse wrinkles. The posterior region of the gut was devoid of them. No branchiæ were present. The transparent tube is secreted by the annelid, and after it left it the body readily adhered to the forceps, a thread of secretion fixing it to the instrument. Minute papillæ were present on the posterior (narrow) part of the body, and thus it resembled *Arenicola*. Two œsophageal cæca occur in front of the stomach. A similar form with one or two additional pairs of bristles was found in the bottom net on the 2nd May. Young stages $7\frac{1}{4}$ mm. long, with nineteen setigerous segments and no gills, and a later stage with eleven pairs of gills, come from Dublin Bay (Southern).

In a post-larval form (Plate XCIV, fig. 2), about half an inch in length, from extreme low-water mark at St. Andrews in September, 1864, there were four minute eyes anteriorly, and a notch marked the oral aperture. The body was of a general translucent greenish-straw colour, whilst the red blood was most conspicuous in the two sub-intestinal vessels. The cœlomic fluid was pale. The œsophageal cæca were finger-like, and the canal was dilated at their origin. The bristles were slender and slightly curved at the winged point, and the hooks were short and curved.

In post-larval forms four or five eyes are observed on each side of the prostomium—embedded in the ganglionic layer of the brain (Gamble and Ashworth). They consist of a cup-shaped mass of brown pigment-granules partially enveloping a clear solid-looking body which projects outward. Similar eyes occur in one 25 mm. long. It is difficult to say whether these are present in the adult, from the great quantity of the pigment.

Gamble and Ashworth[1] show that the young *A. marina* may safely be distinguished

[1] 'Quart. Journ. Micr. Sci.,' vol. xliii, N.S., pp. 533–534.

by the open statocyst with foreign statoliths, the single pair of œsophageal pouches, and the small pair of nephridia in the third bristled segment.

A. marina was first described by Belon (1553), and was referred to in Britain by Carew (1602), and by Willoughby more minutely. Most marine zoologists since that date have alluded to this species, which, however, in the southern European seas has been often confounded with other species as shown in Dr. Ashworth's monograph.

Pallas (1784) in his 'Marina Varia Nova et Rariora' considers the position of *Arenicola* as between the Nereids and Lumbrici.

G. Meissner [1] (1857) found the otocyst or statocyst in *Arenicola*.

The *Clymenides sulphurea* of Claparède [2] (1863) is, as several authors have shown, apparently the young of *Arenicola marina*, but his drawings of the bristles and hooks are indefinite.

In Wirén's 'Anat. and Histology of the Limivorous Annelids' (1887) he gives good sections of *Arenicola* and *Scalibregma*. In the latter (Plate III, fig. 3) he does not distinguish between the transverse muscle which passes entirely across and above the lateral ventral projections, and the bands which pass on each side into the lateral swellings. The oblique muscle in *A. marina* he terms transverse. He shows the blood-channels interdigitating between the folds of the digestive system. He gives interesting figures of the circulation.

Jaquet [3] (1886) describes at considerable length the circulation in *Arenicola piscatorum*.

Wilson [4] (1880) and Child [5] (1900) give the early stages of *A. cristata* of N. America up to the trochophore stage. Post-larval stages of *A. marina* were described by Benham [6] (1893) and Kyle [7] (1896). Leschke [8] also found similar stages at Kiel.

Cosmovici (1880) gave an account of the general structure of *A. marina*, describing, amongst other things, what he terms the organ of Bojanus developed on minute blood-vessels in connection with his *cul-de-sac*—both central and peripheral. One set of these organs of Bojanus he associated with the segmental organs which serve for the evacuation of the sexual products.

Carus (1885) states that this species is termed "Cassoli" at Genoa; at Naples "Esca di fango colla lana in coppa" (Claparède).

Dr. Charles Davison [9] (1891), from observations made at Holy Island, has calculated that in an acre of sand about two thousand tons are brought up by the lob-worms and deposited on the surface. The effect, therefore, of the action of these annelids on a beach is geologically important. Similar results are detailed more recently by Dr. Ashworth.

Ehlers [10] (1892) gave an account of young Arenicolæ, chiefly in the pelagic condition,

[1] 'Vergl. Zeitschr. f. rationale Medicin, Bericht.,' p. 633, Note.

[2] 'Beobacht. Anat. Entwickl.,' p. 30, Taf. xv, figs. 24—27.

[3] 'Mitt. Zool. St. Neap.,' Bd. vi, p. 347, pls. xxi and xxii, figs. 50—64.

[4] Observat. on Early Stages Polychæt., 'Zool. Anzeig.,' 1880; also in 'Journ. Morphol.,' vol. vi, 1892.

[5] 'Archiv f. Entwickelungsmech.,' vol. ix, p. 587.

[6] 'Journ. M. B. A.' (2), vol. iii, p. 48.

[7] 'Ann. Nat. Hist.,' ser. 6, vol. xviii, p. 298.

[8] 'Wissensch. Meeresuntersuch.,' Bd. v, p. 125.

[9] 'Geol. Mag.,' Decade III, vol. viii, p. 489.

[10] 'Nach. Köengl. Gesellsch. Wissensch.,' Göttingen, 1892.

from Heligoland. The same year[1] he wrote an important paper on the "auditory" organs of *Arenicola marina*, *A. Claparedii*, *A. Grubei*, *A. antillensis*, and reviewed the occurrence of homologous organs in other annelids.

In a careful account of this species by De St. Joseph (1894), he mentions that he found on the branchiæ *Rhabdostyla arenicolæ*, Fabre Domergue.

Fauvel (1899) considers the following as the young form in the abranchiate condition, viz. *Clymenides sulphurea*, Claparède,[2] De Quatrefages, Mesnil, and himself. He gives somewhat later (the same year) an elaborate account of the three young forms which Claparède and Mesnil considered as pertaining to a different genus, viz. *Clymenides sulfureus*, *C. ecaudatus*, and *C. incertus*, and decides that they are respectively only the young of *Arenicola marina*, *A. ecaudata*, and *A. Vincenti*. The same author[3] has contributed an account of the pigment in the group.

Willem[4] (1899) describes the excretion in this species, treating first of the physiological chemistry of chloragogenous tissue, then of excretions by amœbocytes in the cœlomic cavity, and lastly, of the structure and functions of the nephridia under the heads of funnel, middle region, and terminal vesicle.

Ashworth (1901) follows Benham's classification of Annelids, *Arenicola* being under the Arenicolidæ. He states that it contains two genera—*Arenicola* and *Branchiomaldane*. This author examined the Arenicolidæ in the Parisian Museum, and mentions an example of *A. marina* with only eighteen bristled segments and twelve pairs of branchiæ instead of thirteen.

The blood of *Arenicola* has again been examined by Peyréga[5] (1912), who finds that the hæmoglobin in it differs little from that in the horse.

One of the most complete, as well as most recent accounts of this form and its allies, has been given by Dr. Ashworth[6] (1912), who has made a special study of the Family, and his excellent commentary on the notices by other authors has simplified the present task. Moreover his careful investigation of the various types has enabled him to rectify several errors in distribution and in structure.

Caullery and Mesnil found *Echinostomum leptosomum* (a distome) encysted in *Arenicola marina*.

Sub-Family II.—Arenicolidæ ecaudata, Johnston.

Head (prostomium), simple, conical, non-lobate. Brain commissural. Statocysts closed spherical sacs, statoliths spherical. Body almost uniform in diameter, without a tail, as the feet and gills (which commence on the sixteenth segment) go to the posterior end. Number of gills variable (according to age and species), unilaterally branched. One pair of flask-shaped œsophageal pouches. Dorsal lip of segmental organs (the

[1] 'Zeitschr. f. wiss. Zool.,' Bd. liii, Suppl., p. 217, Tab. xi—xiv.
[2] 'Bull. Sc. France et Belgique,' t. xxxii, p. 283, pl. iii.
[3] 'Rev. Scientif.' (4), t. xiii, p. 54.
[4] 'Observat. sur l'excretion chez l'Arenicole,' 4to, Lille, 2 pls.
[5] 'Compt. Rend. Acad. Sc.,' t. cliv, pp. 1732—1734.
[6] 'Catalogue of the Chætopoda.' A. "Polychæta." Part I, "Arenicolidæ": British Museum.

number of which is thirteen pairs, viz. from the fifth to the seventeeth) bearing somewhat cylindrical, digitiform, often branched, ciliated vascular processes; ventral lip deeply notched in middle of semi-circular halves. Ova oval with a thick zona. The reproductive organs larger than in other species of *Arenicola*.

1. Arenicola ecaudata, *Johnston*, 1835. Plate LXXXVIII, fig. 8; Plate XCV, figs. 10 and 10 *a*—ventro-lateral view and anterior end; Plate CIII, figs. 13—13 *b*—bristles and hook.

Specific Characters.—Prostomium conical; otocysts closed, with a number of spherical refringent otoliths. Proboscis with soft, rounded papillæ. Nineteen to forty pairs of gills, the first on setigerous segment 16; 3—9 terminal segments devoid of branchiæ. Thirteen pairs of segmental organs opening on segments 5—17. Twelve pairs of large gonads. Testis in male produced into one or more large, thin reniform lobes; ovary in female with as many as thirty digitiform vascular processes bearing ova. 130—180 mm. long. Anterior diaphragm with two elongated sacs; abdominal diaphragms from the eighteenth bristled segment. Dorsal bristles alternate, with a very narrow wing; hooks with a longer or more acute rostrum than in *A. marina*, and the two spines on the crown are larger and longer. Yellowish-red or dark red, and some are dark green with metallic lustre. The post-larval form is distinguished by the extension of the bristles and hooks almost to the hinder extremity and the closed statocsyts. Thirteen pairs of segmental organs. A hook temporarily occurs in the dorsal division of the foot in the last six segments.

Synonyms.

1835. *Arenicola ecaudata*, Johnston. Loudon's Mag. Nat. Hist., viii, p. 566, f. 54.
1840. „ „ sp., Grube. Anat. Kiemen., p. 3.
1842. „ „ Chenu. Illust. Conch., i, pp. 1, 12, pl. i, fig. 5.
1843. „ *Bœcki*, Rathke. Nova Acta Acad. Leop.-Car., xx, p. 181, tab. 8, f. 19—22.
1851. „ *branchialis*, Grube. Fam. Annel., pp. 76 and 136.
1853. *Lumbricus marinus* (another species), Dalyell. Pow. Creat., ii, p. 137, pl. xix, figs. 4—7.
„ *Arenicola Bœcki*, Sars. Nyt Mag. f. Naturvid., vii, p. 381.
1865. „ *ecaudata*, Johnston. Cat. Worms Brit. Mus., pp. 231, 345, fig. 42.
„ „ *branchialis* (*partim*), idem. Ibid., p. 231.
„ „ *ecaudata* and *Bœcki*, De Quatrefages. Annel., ii, pp. 265 and 266.
1866. „ „ Lankester. Ann. Nat. Hist., ser. 3, xvii, p. 390.
1867. „ „ Malmgren. Annul. Polych., p, 79.
1870. „ „ McIntosh. Rep. 39th Meet. Brit. Assoc., p. 90.
1873. „ „ Lapont. Act. Soc. Linn. Bordeaux, xxviii, p. 264.
1874. „ „ Malm. K. Vet. Handl. Göteborg, xiv, pp. 88 and 189.
1879. „ „ Tauber. Annul. Danica., p. 110.
1880. „ „ Storm. Kgl. Norske Vidensk Selsk. Skr., p. 95.
1883. „ „ Levinsen. Aftr. Vid. Meddel. Foren. Kjöbenh., p. 92.
1885. „ „ Koehler. Ann. Sc. nat., sér. 6, t. xx, art. 4.
1886. „ „ Harvey Gibson. First Rep. Fauna Liverp. Bay, p. 156.

1888. *Arenicola branchialis* (*partim*), Marenzeller. Zool. Jahrb., t. iii, p. 13 (Angra Pequena).
1891. „ *ecaudata* (*partim*), Ives. Proc. Acad. Nat. Sc. Philad., 1890, p. 74.
1894. „ „ Bidenkap. Christ. Vidensk. Selsk. Forhandl., No. 10, pp. 39, 112.
1896. „ *branchialis*, Michaelsen. J.-B. Komm. Wiss. unters, Kiel, ii, p. 136.
1897. *Clymenides ecaudatus*, Mesnil. Bull. Sc. France et Belgique, t. xxx, p. 152, pl. vi, fig. 12—14 (post-larval stage).
„ *Arenicola branchialis* (*partim*), Fauvel. Proc. 4th Internat. Congr. Zool, p. 229.
„ „ *ecaudata*, Ashworth. Trans. Liverp. Biol. Soc., xi, p. 30.
„ „ *branchialis* (*partim*), Mesnil. Bull. Sc. Fr. Belg., t. xxx, p. 163.
1898. „ *bucci*, Hanna. Proc. Belfast Natur. Field Club, ser. 2, iv, p. 425.
„ „ *ecaudata*, Fauvel. C. R. Acad. Sci. Paris, cxxxv, p. 733.
„ „ „ Mesnil. Zool. Anzeig., xxi, p. 631.
„ „ *branchialis*, De St. Joseph. Ann. Sc. nat., sér. 8, t. v, p. 391, pl. xxii, figs. 201, 202.
1899. „ *ecaudata*, Fauvel. Bull. Sc. Fr. Belg., xxxii, p. 289, etc.
„ „ „ idem. Mém. Soc. Nation. Sci. Nat. etc., Cherbourg, xxxi, p. 163.
1899. „ „ Mesnil. Bull. Soc. Fr. Belg., xxxii, p. 318.
„ „ „ Fauvel. Bull. Soc. Linn. Normand., 5^{e} sér., t. ii, p. 64, pl. i.
1900. „ „ Gamble and Ashworth. Quart. Journ. Micr. Sci., vol. xliii, N.S., p. 423 *et seq.*, pl. xxii, fig. 4, etc.
„ „ „ Beaumont. Proc. Roy. Irish Acad., ser. 3, v, p. 784.
1901. „ „ Ferronnière, Bull. Soc. Sc. Nat. Ouest Fr., sér. 2, t. i, p. 19.
„ „ „ Gemmill. Fauna of Clyde Area, p. 361.
1904. „ „ Journ. M. B. A., N.S., vii, p. 231.
„ „ „ Ashworth. L.M.B.C. Memoirs, No. xi, p. 75, etc.
1906. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 334.
„ „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. i, p. 382.
1909. „ „ Ashworth. Fisheries Ireland Scient. Invest., 1908, ii, p. 2.
1910. „ „ Ashworth. Mitt. Zool. Mus. Berlin, Bd. iv, p. 354.
„ „ „ idem. Ann. Sc. nat., sér. 9, t. x, p. 114.
„ „ „ Southern. Proc. Roy. Irish. Acad., vol. xxviii, p. 239.
„ „ „ Elwes. Journ. M. B. A., N.S., ix, p. 64.
1912. „ „ Ashworth. Cat. Chætop. Brit. Mus., p. 132, pl. ii, figs. 7, 8; pl. ix, fig. 19; pl. xi, figs. 34, 35; pl. xv, figs. 52, 53.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 134.

Habitat.—Near low-water mark, under stones, on a gravelly beach on a little island in Lochmaddy, and also dredged in the loch. Guernsey, Jersey, and other Channel Islands (W.C.M.); Plymouth (Spence Bate, and Rowe); Isle of Man; near Fairhead, Antrim (Ashworth). Great Aran Island (Scharff); East Aran Island, Salthill, Co. Dublin; Rock-pools, Killeany Bay, Co. Antrim; and Valencia, Bantry Bay (Roy. Irish Acad.) Torquay, burrowing in soft mud and sand under stones in gravel. More characteristic of the southern than the northern shores of Britain, though it is less common than *A. branchialis* in Guernsey and Herm.

Abroad it is found in Norway (Rathke); Sweden; Baltic; French coast; Mediterranean; Black Sea; Atlantic.

Head (Plate XCV, fig. 10 *a*) bluntly conical and slightly flattened, marked by a median and two lateral grooves on each side. The slightly narrower region behind is devoid of feet and bristles, the anterior part being differentiated by the mid-dorsal neck

and pit of the nuchal groove, but the first segment is probably united with the peristomium behind, certain rings pertaining to the one and certain to the other.

The arms of the nuchal organs or ciliated grooves commence ventro-laterally, and run upward and backward, but, before meeting on the dorsal surface of the prostomium, they bend sharply backward, and then unite in a short transverse line. The thickened lips are nearly black and fairly wide apart, and thus contrast with the pink tint at the bottom of the groove. In place of the cerebral lobes of *A. marina* there are several posterior outgrowths of the commissure-like brain which resemble nerves. In some specimens, however, a median process of the brain underlies the dorsal part of the nuchal groove, which is present in the post-larval specimens of *A. ecaudata* 7·2 to 9·4 mm. long.

The brain is commissural in form, and merely unites the ends of the œsophageal connectives. The ventral nerve-cord is cœlomic throughout in this and *A. branchialis*. Six giant-cells occur in segments two to seven. Gamble and Ashworth insist that the giant-fibres arise in all cases from giant-cells segmentally arranged. "The exact connection of the giant-fibre with the cord, and especially the connection of its branches and of those of the more inconstant lateral giant-fibres, require further investigation, but we (Gamble and Ashworth) have shown that in *A. branchialis* the branches accompany the peripheral nerves, and are connected by short offsets with the fibrous matter of the cord, thereby increasing their likeness to efferent nerve-fibres."

Ashworth,[1] in *Arenicola cristata* (Gamble and Ashworth, 1900, p. 443, and Plate XXIV, fig. 33), describes small papillæ or sometimes depressions corresponding in position to those of the sense-organs of the Capitellidæ, *Scalibregma*, *Ophelia*, etc., but their structure could not be demonstrated.

Eisig thinks the sense-organs modified cirri, and that the foregoing would represent the dorsal cirrus of the ventral division. Ashworth disagrees, pointing out that the feet of the Glyceridæ are, though occasionally single, truly biramous. Eisig's contention that such a foot in the Glycerids is equivalent to the ventral division only does not hold good.

Ten narrow rings occur in front of the first foot.

Body (Plate XCV, fig. 10) about 6 in. or more in length, of a brownish iridescent hue, darker at the snout and posteriorly. Some are of a very dark deep green colour, and tinge spirit to a deep green hue. The branchiæ are of a dull red, and on the whole more conspicuous than in *A. marina*. They commence on the seventeenth bristled segment, and continue, though smaller, to the posterior end, the last, however, being represented only by a single papilla. So far as could be observed the gill is more finely branched at the tips than in *A. marina*, but the stems seem to be proportionally fewer and thicker, and to arise from a basal part, so that the character of the gill differs. Gamble and Ashworth note that the stems bifurcate, and then the posterior becomes dichotomous near its tip.

In a post-larval form (7·2 mm. long) a linear series of twelve eyes occurred on each side of the prostomium. The anterior eyes are placed in the nervous layer and on the course of the nerves from the front edge of the commissural brain to supply the pros-

[1] 'Quart. Journ. Micr. Sci.,' vol. xlv, N. S., p. 276.

tomium. Further back they are sunk in the ganglionic layer of the brain itself. In specimens 6 in. to 7 in. long more numerous eyes are present.

The proboscis of this form agrees in general structure with that of *A. marina*, considerable variation occurring in the extent of the large basal series of papillæ, and in the coloration from pale to blackish. The large papillæ at the base of the extruded organ, however, have the form of small craters with an elevated rim and a depressed centre. The small papillæ are also proportionally larger than in *A. marina*, and a smooth area occurs at the œsophageal infolding.

The rings bearing feet and branchiæ are broader and more prominent than the rest, and they are followed by four well-marked narrower rings, the last being the narrowest, and this appears to be the general arrangement to the tip of the tail, the last foot being followed by a distinct ring, and then a terminal region which has a median constriction so that it is more or less double. The anus is in the centre of the tip posteriorly.

Gamble and Ashworth note that oblique muscles are absent from the anterior portion of this species and *A. branchialis* in front of the second or third gills. Beyond this point they are feebly developed. Thus the nephridia with their nephrostomes are clearly seen on opening the body, and make a striking difference between them and the other three species of *Arenicola*.

The setigerous processes are somewhat longer and narrower than in *A. marina*, and the bristles (Plate CIII, figs. 13 and 13 *a*) are much more attenuate at the tip, which has a very narrow wing, the edge being minutely spinous. The whorls of spines at the tip are finer and less conspicuous than in *A. marina*, but the essential structure seems to be the same. The surface of the shaft appears to be roughened by minute spines as in *A. marina*.

The hooks (Plate CIII, fig. 13 *b*) are less robust and have a longer and more acute rostrum than in *A. marina*, and the spines on the crown are larger and longer, one long anterior spine and another above it being conspicuous. When seen antero-posteriorly these appear to be double. The neck below the rostrum is boldly obliquely striated from behind forward. The striated enlargement in the middle of the bristle is well-marked, and so is the basal backward curve (the tip of the rostrum being in front).

Gamble and Ashworth consider that both bristles and hooks of this and *A. branchialis* are so nearly alike that no constant point of difference can be detected. The shaft of the hook has a moderately long rostrum tapering somewhat toward its point, behind which are two or three teeth. In older ones there is often a very slight process beneath the rostrum. In young examples the minute hooks have two curved spines in lateral view above the rostrum, and the dilatation of the shaft is marked. As these authors show, the angle of the rostrum is nearly a right angle, whereas it is much greater in the adult, and the rostrum itself is proportionally larger. Some present a short process on the throat at this stage. The hooks of *A. ecaudata* and *A. branchialis* never attain great length (Gamble and Ashworth).

In the post-larval forms (7·2 mm. long) there are bristles with a lamina on one side of the distal third or half, a short proximal region (of the lamina) devoid of hairs, and a longer distal part with distinct hair-like processes, "while between the two the seta is slightly constricted" (Gamble and Ashworth). This form is the *Clymenides ecaudatus* of

Mesnil. A hook indistinguishable from the ventral occurs in some of the posterior tufts of bristles, and this was also found by Mesnil in the form just mentioned.

There are thirteen pairs of nephridia, viz. from the fifth to seventeenth setigerous rings. They resemble those of *A. branchialis*, except that the funnel is often narrower from side to side, and the dorsal lip bears a greater number of processes. All have gonads. The bladder is generally larger. Ripe ova in the females often accumulate in the vesicle so as to make a thin walled sac—like an outgrowth of the vesicle.

Reproduction.—Gamble and Ashworth state that they breed in spring (April at Port Erin).

A large female from Great Aran Isle (Dr. Scharff) in September was taken with large thick-shelled ova, and Dr. Ashworth mentions that he had ripe examples from Plymouth at the end of August. Fauvel found the period range from March to October.

Ovaries and testes are so voluminous as to conceal the greater part of the segmental organs and the alimentary canal. In the male the gonad is a capacious sac, in the female a tuft of follicles. The gonads are larger, more complicated, and more numerous (twelve pairs) than in *A. branchialis*. The strands of the first pair of segmental organs do not give rise to gonads. The ova are retained in these till almost ripe, and thus they differ from those of other species. In their long diameter the ova are 0·13 mm. to 0·14 mm. and have a thick vitelline membrane. The male genital cells fall from the testes after two or three divisions and complete the development in the cœlomic fluid. Gamble and Ashworth found in August, in the roots of *Laminaria*, young examples from 7·2 mm. to 9·4 mm. which they considered only a few months old. They had thirteen pairs of segmental organs, but no gills. Fauvel (1899) shows that these young live amongst algæ in a gelatinous tube, only later when the gills are well-developed do they live in sand.

The smallest example procured between tide-marks at Lochmaddy (August, 1865) measures in spirit about 4 mm. in length, but it would probably stretch considerably more in life. No branchiæ are present. Moreover the body does not show the abrupt narrowing of the caudal region behind the bristles so characteristic of the pelagic young of *A. marina* procured in the bottom-net. The anterior rings are wide, whilst the posterior are numerous and narrow. There are between fifty and sixty bristled segments.

The next stage is represented by a specimen about 7 mm. in length, also obtained between tide-marks at Lochmaddy. In front of the first bristle-tuft are the somewhat large blunt prostomium, and five rings. The setigerous lobes are distinct, and the first gill arises on the sixteenth. As the anterior segments are much broader than the posterior the branchial region occupies nearly half the length, and is characterised by a deep furrow on the dorsum of the preparation. In the anterior half a single ring is interpolated between the setigerous lobes, but the feet are so crowded posteriorly that no more than one ring to each is present at this stage. The branchiæ (more than forty pairs) are for the most part simple filaments, or a pair of filaments, and they appear to be longest anteriorly. The bristles are proportionately larger than in the adult and have a trace of a wing on each side. The anus is median and papillose.

The third stage, also obtained in August, is about 11·5 mm. in length and the same general shape is maintained. The gills commence as a small simple process on the fifteenth segment, and a longer slightly branched organ on the sixteenth. About forty

pairs of gills are present, but the caudal region with bristles is longer. Except the simple gill on the fifteenth, all show short secondary processes, especially anteriorly where they form short branched tufts. Moreover, another example almost the same length had somewhat longer gills in front, whilst a third agreed with the first.

The fourth stage is 16 mm. long, from Salthill, Co. Dublin, in August. The pigment is boldly marked anteriorly, the snout in front of the nuchal groove being dark brownish (in spirit), the nuchal grooves forming a broad V with the concavity forward. Then a broad dark belt succeeds with a paler area behind. This is followed by three blackish-brown segments, and the rest of the body is pale brown. The bristle-tufts and the rows of hooks are marked by pale areas and bands, the latter continuing after the branchiæ on the sixteenth make their appearance. The gills are longer and more distinctly branched.

When $1\frac{3}{4}$ in. long it is found, amongst other situations, at Lochmaddy in the interstices of the roots of Laminariæ dredged beyond low-water mark. The colour is dull greenish-yellow with very finely-branched red branchiæ, though the tips of these organs are paler, apparently from the minute subdivision of the branches. Branchiæ were not observed on the four segments in front of the pygidium. Anteriorly the segments are distinctly marked —broader in front, narrower posteriorly. The snout is slightly redder than the rest of the body.

Gamble and Ashworth (1900) state that the post-larval form may be distinguished from that of *A. branchialis*, which also has statocysts, and the gills and feet are continued to the posterior end of the body, by the presence of thirteen pairs of segmental organs.

Habits.—It frequents tracks under littoral stones and in clefts of rocks, and has no regular burrow as in *A. marina*. At Valencia a little sand and fragments of Fucus occur in the gut, and the coarse fœcal coils do not form piles as in *A. marina*, some falling to pieces, in this respect agreeing with *A. branchialis* (Gamble and Ashworth). It secretes abundant and tenacious yellowish-green mucus as in *A. marina*. Fauvel found that at night captive specimens left the sand and moved about at the surface of the water, swimming freely.

Naturalists owe this species to the acuteness and life-long devotion of Dr. George Johnston, of Berwick, who recognised its distinction from the common form. He mentions that the smallest number of pairs of branchiæ he had met with was twenty-two, and the first few pairs were smaller than those about the middle, whence they again decreased towards the tail. He separated the variety *branchialis* as a distinct species, and mentions three varieties of Leach's in the British Museum, viz. *nodosa*, *Montagui*, and *Dorvilliana*.

This lob-worm formed the subject of the first chapter of Grube's 'Anatomie u. Physiologie der Kiemenwürmer' in 1838, and his treatment of it, structurally and otherwise, was in consonance with the distinction he afterwards achieved in the department.

A figure (Plate XXIX, fig. 33) given in Delle Chiaje's 'Memorie' (1828), though inexact, may refer to this species, since the branchiæ are carried to the tip of the tail.

The *A. Montagui* of Leach in the British Museum is this species.

Rathke[1] (1843) considered this form different from *A. branchialis* of Milne Edwards, and apparently it was a young example, measuring $1\frac{1}{2}$ in. in length.

[1] 'Fauna Norwegens,' *olim cit.*

This is probably the *Lumbricus marinus*, "another species," of Dalyell[1] (1853).

Levinsen (1883) included the *Arenicola branchialis* of Audouin & Edwards under this species, but, as shown by Ashworth, it essentially differs.

Fauvel[2] (1899) gave a description of the structure of this form, pointing out its distinctions from *A. marina*, especially in the circulatory system and nephridia, outlines of the latter in both sexes being shown. He considers the *Clymenides ecaudatus* of Mesnil and himself as the young of this species, and Ashworth agrees. It is noteworthy that this form and *A. branchialis* have closed statocysts or otocysts with otoliths secreted by the organ, whilst *A. marina* has ducts to its otocysts and foreign particles of quartz as otoliths.

J. T. Cunningham[3] (1907) describes a curious Protozoan parasite (*Kalpidorhynchus arenicolæ*) occurring in white cysts in the cœlom, and elongated forms attached to the wall by one extremity. He refers to the gametocytes, gametocyst, and forms of gametes. The spores are octozoic.

2. Arenicola branchialis, *Audouin and Edwards*, 1833. Plate LXXXVIII, fig. 9; Plate CIII, figs. 12—12 *c*—bristles and hooks.

Specific Characters.—Prostomium simple, club-shaped or truncated in front, without lobes. Eyes present. Statocyst rounded, and the statoliths spherical. A pair of flask-shaped œsophageal sacs. Anterior region of eleven to twelve uncinigerous abranchial segments. First gill[4] on setigerous segment twelve. Five pairs of segmental organs opening on segments five to nine. Twelve to twenty-eight pairs of gills, commencing on the twelfth bristled segment. Gonads small. Thirty to forty-five setigerous segments. No distinct tail; feet conspicuous from the branchial region to the end of the body. Dorsal bristles fine, with narrow wings. Hooks with one or two spikes on the crown.

Colour generally dark green, but also dark red or yellowish-red, with metallic lustre.

The post-larval form has the gills, bristles and hooks extending almost to the posterior end of the body; the otocysts are closed. Five pairs of segmental organs.

Synonyms.

1827. *Lumbricus marinus* (*partim*), Delle Chiaje. Mem. Anim. Invert., ii., p. 423.
1833. *Arenicola branchialis*, Audouin and Edwards. Ann. Sc. nat., xxx, p. 422, pl. xxii, fig. 13.
1834. „ „ idem. Hist. Nat. Litt. Fr., ii (Annel.), p. 287, pl. viii, fig. 13.
1838. „ *eine andere Art*, Grube. Anat. Physiol. Kiemenw., p. 3.
1841. „ *piscatorum* (*partim*), Delle Chiaje. Descriz., p. 100.
1843–53. „ *branchialis*, Chenu. Illustr. Conch., pp. 1, 12, pl. i, fig. 6.
1853. „ „ (near to), Gosse. Ramb. Devon., p. 174.
1865. „ „ De Quatrefages. Annel., ii, p. 265.
„ „ „ Cailland. Ann. Sc. Acad. Nantes, xxxvii, p. 28.
„ „ „ Johnston. Cat. Worms Brit. Mus., p. 345.
„ „ „ (*partim*), idem. Ibid., p. 231.
1868. „ *Grubei*, Claparède. Annél. Nap., p. 296, pl. xix, fig. 2.

[1] 'Pow. Creat.,' ii, p. 137, pl. xix, figs. 4—7.

[2] 'Bull. Soc. Linn. Normandie,' 5e sér., vol. ii.

[3] 'Archiv Protist.,' p. 199, 2 pls.

[4] The first gill is often small, and frequently absent on one or both sides (Ashworth).

1870. *Arenicola Grubei.* Claparède. Mém. Soc. Phys. Genève., xx, p. 36.
„ „ *branchialis,* Bobretzky. Mém. Soc. Nat. Kiev, i, pp. 6, 248.
1872. „ *ecaudata,* Grube. Schles. Ges. Vaterl. Cult., Abt. Nat., pp. 91, 106, 142.
1881. „ *Grubei,* Horst. Tijdschr. Nederl. Dierk., Ver., Dl. v, pp. 125, 126.
„ „ *cyanea, dioscurica, and Bobretzkii,* Czerniavsky. Bull. Soc. Imp. Nat. Moscow, vol. lvi, pp. 353—356, pl. iv, fig. 4 (Gamble and Ashworth).
1884. „ *Grubei,* Jourdan. C. R. Acad. Sc. Paris, xcviii, p. 757, and Ann. Nat. Hist., ser. 5, vol. xiii, p. 488.
1888. „ *branchialis* (*partim*), Marenzeller. Zool. Jahrb., Abt. Syst., iii, p. 13.
1889. „ *Grubei,* Horst. Notes Leyden Mus., ii, pp. 37—45, pl. iii, figs. 12—15.
1891. „ *ecaudata* (*partim*), Ives. Proc. Acad. Nat. Sc. Philad., p. 74.
1892. „ „ Jourdan. Ann. Sc. nat., 7e sér., t. xiii, p. 227, pls. v and vi, figs. 10—12.
„ „ *Grubei,* Ehlers. Zeitschr. f. wiss. Zool., Bd. liii, suppl., p. 249, pl. xiii, figs. 33—37; pl. xiv, figs. 38—48.
1893. „ „ Lo Bianco. Atti. R. Acad. Sc. Napoli, ser. 2, vol. v, No. 11, p. 10.
1896. „ *branchialis* (*partim*), Michaelsen. J.-B. Komm. Wiss.-unters. Kiel, N.F., ii, p. 136.
1897. „ „ idem. Polych. deutsch. Meere, p. 136.
„ „ „ (*partim*), Mesnil. Bull. Sc. Fr. Bdg., xxx, p. 163.
1898. „ *Grubei.* Gamble and Ashworth. Quart. Journ. Micr. Sc., N.S., vol. xli, p. 33.
„ „ *branchialis* (*partim*), De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 209—466.
„ „ „ Mesnil. Zool. Anzeiger, vol. xxi, p. 631.
1899. „ *Grubei,* Fauvel. Bull. Sc. Fr. Belg., xxxii, p. 292.
„ „ „ idem. Mém. Soc. Nation. Sc. Nat. Cherbourg, xxxi, p. 166.
„ „ *branchialis,* Mesnil. Bull. Sc. Fr. Belg., xxxii, p. 318.
„ „ *Grubei,* Lo Bianco. Mitt. Zool. Stat. Neap., xiii, p. 484.
1900. „ „ Gamble and Ashworth. Quart. Journ. Micr. Sci., N.S., vol. xliii, p. 423 *et seq*, pl. xxii, fig. 3.
„ „ „ Beaumont. Proc. Roy. Irish Acad., ser. 3, vol. v, p. 784.
1901. „ „ Ferronnière. Bull. Soc. Sc. Nat. Ouest Fr., sér. 2, i, pp. 39, 53.
„ „ „ Allen and Todd. Journ. M. B. A., N. S., vi, p. 195.
1904. „ „ Ashworth. L. M. B. C. Memoirs, No. xi, p. 75, etc.
„ „ „ Journ. M. B. A., vol. vii, p. 230.
1908. „ „ McIntosh. Ann. Nat. Hist, ser. 8, vol. i, p. 382.
„ „ „ Schiller. Jenaische Zeitsch. der Naturwiss., pp. 293—320.
1909. „ „ Ashworth. Fisheries Irel. Sc. Invest., ii, p. 2.
„ „ „ Lo Bianco. Mitt. Zool. Stat. Neap., xix, p. 577.
„ „ „ Fauvel. Bull. Inst. Ocean., cxlii, p. 8.
1910. „ „ Ashworth. Mitt. Zool. Museum, Berlin, Bd. iv, p. 353.
„ „ „ idem. Ann. Sc. nat., 9e ser., t. x, p. 113.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 136.

Habitat.—Lochmaddy, N. Uist, between tide-marks under stones on a gravelly bottom, August, 1865, and August, 1872, and on small islands adjoining, as well as dredged in the loch in the crevices of laminarian roots.

English Channel; Plymouth; the Channel Islands; Isle of Man (Ashworth). Loch Linnhe; Valencia, Ireland; Clare Island district (Southern).

Characteristic of the southern and western shores of Britain. Lives in sinuous galleries near low water (Ashworth).

Elsewhere it occurs on the shores of the Mediterranean, French coast, the Atlantic, and the Black Sea.

The *Snout* forms a blunt cone, the tip of which is rugose, the furrows being longitudinal, and a bifid process occurs beneath in the middle line in front. Posteriorly it ends in the median bite which has a border behind, and the sides of which in front project inward, the nuchal groove then turning slightly backward and downward to the ventral surface. In softened specimens the aspect differs, the head having a median peak posteriorly from each side of which a band passes obliquely outward and backward, though they are often covered by the deep fold behind. In extrusion of the proboscis, the median neck or band is conspicuous when the posterior fold is drawn back, and the lateral bands are nearly transverse. In some the median process of the head fits into the notch in the ring behind, the edges of the notch being fixed to the sides of the median process, and it is probably these which in softened specimens have the aspect of bands. In others no notch exists in the ring behind the head, the edge of the segment passing evenly round to the ventral surface, and the lateral fold on each side of the median process is less

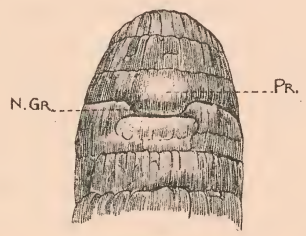

FIG. 109.—Snout of *Arenicola branchialis* from the dorsum. *N. Gr.* Nuchal groove. *Pr.* Prostomium. After Dr. Ashworth.

distinct. Considerable variation thus exists both in regard to states of contraction of the lateral folds and the edge of the ring behind the head.

The arms of the nuchal groove follow the same direction as those of *A. ecaudata* (p. 74), but the lips are more closely apposed. The organ has the same innervation. The position of the statocyst in the peristonium is indicated by a slight depression a little dorsal to the point of intersection of the second of the circular grooves with the metastomial grooves (Gamble and Ashworth).

The ventral nerve-cord has a single neural canal in front. In segments five to ten, two, in the central region of body three, and posteriorly only one. They arise from the giant-cells of the cord (Gamble and Ashworth). Eyes present in post-larval forms as in *A. ecaudata*.

Length 8 or 9 in. or perhaps more. Of a uniform blackish-green colour with bluish iridescence; branchiæ dull red. A small tail exists in some behind the last bristles, two of which occasionally exceed the line of the branchiæ. The green tint emitted on immersion in spirit is strikingly beautiful. There are eleven anterior abranchiate segments.

Small forms from low-water mark, Lochmaddy, about 2 in. long, are of a uniform straw-yellow colour, with finely branched branchiæ, and the extruded proboscis is also yellow. Ashworth again records adults as generally very dark—from bluish-black to dark green.

The proboscis corresponds generally with that of the other British forms, the large basal papillæ also often being dark. In small examples from Naples the proportion

between the basal and the smaller papillæ was less than in the larger examples, but this may have been due to the mode of preparation. In some the large basal papillæ show a median pit as in *A. ecaudata*, but the influence of the mode of preparation on this condition has yet to be determined.

The setigerous processes, as prominent as in *A. ecaudata*, are somewhat flattened, and the tip has a slight obliquity externally. The bristles have shafts of moderate strength at the base, but finely tapered, as in *A. ecaudata*, toward the extremity. Fine striæ mark the shaft in its more opaque region, and it tapers from a little above the base to the tip. No evident wing is visible, and the sparse whorls of spikes seem to be limited to the slender and transparent tip (Plate CIII, figs. 12 and 12 *a*).

There is nothing in the outline of the hook (Plate CIII, figs. 12 *b* and 12 *c*) to distinguish it from that of *A. ecaudata*, for whilst in many of the latter the rostrum is sharper, longer, and bent at a more acute angle, such may only be due to less tear and wear. The striæ in both are similar, and a single spine is generally visible in each on the crown of the rostrum.

The first nephridium is sometimes represented only by a funnel, and each seldom exceeds 7 mm. in length. The vascular ciliated processes of the dorsal lip are less flattened; they are stout, cylindrical and digitiform, generally branched distally. The ventral lip is deeply notched in the centre. There are five pairs of openings, viz. from the fifth to the ninth setigerous rings.

Habits.—Littoral, under stones in tracks. No regular burrow. It secretes a great amount of mucus, so that in a short time it covers itself in a glass vessel with a gelatinous coating almost of the density of a *Salpa*.

This species was discriminated by Audouin and Edwards (1834) at St. Malo by its smaller size and the characteristic number and arrangement of its branchiæ.

Reproduction.—Dr. Ashworth observes that in the Irish Sea and the English Channel the breeding season is from September to October. It is mature at Naples during the winter (Lo Bianco, Fauvel). The gonads appear early on the last four pairs of segmental organs, and in annelids only 35 mm. long. The gonads in the adult are club-shaped or cylindrical. The first has a well-developed gonidial vessel, but no genital cells. The ova are the same size as those of *A. ecaudata*, viz. 0·136 to 0·14 mm., and have a thick zona (vitelline membrane).

Claparède (1868) recognised the specific distinctions of Grube's form, to which he gave the name of its author. He corrected the erroneous interpretations of the problematical organs given by Oken, Home, Cuvier, and J. Müller, and confirmed those of Grube and M. Edwards. Instead of being the generative organs, these are the segmental organs, which Claparède located in segments four to eight. He also figures and describes "auditory organs"—originally mentioned by Mettenheimer.

Lo Bianco states that the length is 150 mm., while Gamble and Ashworth record it as 225 mm. in the British area. The body resembles that of *A. ecaudata;* the arrangement of the rings is similar, and the same may be said of the gills. The latter spring from a common origin and show five or six, or more, main stems, which form a kind of rosette, with numerous ultimate branches apparently somewhat dichotomously divided. They diminish posteriorly, the last foot having, perhaps, only a single filament, whilst the

penultimate may have none. The distinctions between the gills of the young or adolescent forms and those of the adults is marked, the latter being much thicker, coarser, and denser. The body tapers a little posteriorly and ends in a conical caudal region of about five rings, the terminal having the anus in the middle.

Fauvel (1899) holds that this was the form described as *Arenicola branchialis* by Audouin and Edwards, whose name therefore has priority, but their insufficient and inexact description gave rise to ambiguity, so that he thinks the more recent name, *A. Grubei*, should stand. This author [1] was formerly inclined to consider *Branchiomaldane* as a stage in the development of *Arenicola branchialis*, but Ashworth's recent investigations would indicate its independence. The three species described by Cerniavzsky refer to this form. The *A. nodosa* of Leach in the British Museum is, according to Ashworth, a typical dark example of *A. branchialis*.

Schiller [2] (1908) gave a careful account of the vascular supply of all the organs in *Arenicola branchialis*.

A small form, procured between tide-marks, along with a Maldanid under a stone at St. Peter Port, Guernsey, July, 1868, approaches *Arenicola*. Anteriorly the proboscis is extruded, and it somewhat resembles that of *Arenicola* with its papillæ and muscular arrangements. On the region immediately behind the foregoing are two globular or rounded protuberances, neither of which appear to represent the tip of the snout of *Arenicola*. Simple bristles occur in front, and vertical rows of minute hooks, after the manner of *Arenicola*, posteriorly.

Family XIX.—Chloræmidæ, *Malmgren*.

Pherusea, Grube; *Siphonostomeæ*, Johnston; *Chloræmiens*, De Quatrefages; *Phérusiens*, Claparède.

Cephalic lobe short, often withdrawn into the buccal, with two grooved tentacles superiorly. Buccal segment short, or produced into a short retractile tube; bristled; branchiæ dorsal, filiform, short, more or less numerous, attached to the buccal lobe or its tube. Bristles of the anterior segments form a guard or cage for the cephalic region. Body vermiform, more or less tumid anteriorly, or sub-fusiform and short; surface with muciparous papillæ; segments comparatively few. Covered with a coating of mucus or with grains of sand, also extending to the papillæ. Blood green; intestine longer than the body. Cœlom with few dissepiments. Feet biramous. Bristles issuing from the skin itself, rarely from processes, articulated; superior capillary, inferior strong and short (crotchets), sigmoidal, or with hook-like tips, few. Dorsal and ventral bristles of the first few segments linear, generally stronger, longer, brilliantly iridescent and arranged in a transverse series, whilst each is articulated in a characteristic manner.

In the structure of the body-wall the longitudinal muscular fibres, both ventral and dorsal, in *Stylarioides plumosa* are thin, and in dilated specimens the separate bands of

[1] 'Compt. Rend. Acad. Sc.,' Paris, t. cxvii, p. 733.

[2] 'Ueber den feineren Bau der Blutgefärse bei den Arenicoliden,' *op. cit.*, pp. 293—320.

fibres are visible through the translucent walls. In transverse section the body-wall is comparatively thin, having externally the papillæ of the cuticle and hypoderm, with the sand-grains and mud, then a tough layer which stains, beneath which is a dense layer which is usually unstained. Though this may only be the inner part of the former, yet it seems to run into or fuse with the circular muscular fibres which form a continuous coat. Both dorsal and ventral longitudinal muscles form continuous bands at their outer borders, but the inner divisions have a tendency to split into separate bundles, which in section are somewhat conical, the base being external. The nerve-cords lie in the space between the ventral longitudinal muscles, the slender oblique muscles passing to their exterior. The cords fuse and form ganglionic enlargements in each segment, and a median mesentery connects the sheath superiorly with the ventral blood-vessel, whilst both in this and the large lateral branch which joins it in each segment, as well as in the dorsal trunk, the contained blood is minutely granular. A branch leaves the ganglion at each

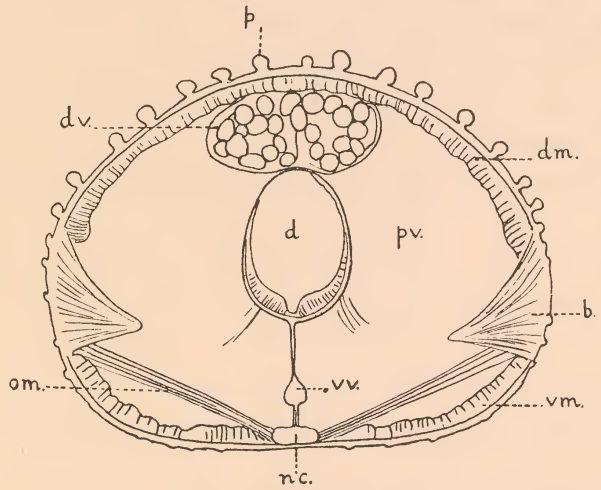

Fig. 110.—Transverse section of the anterior third of *Stylarioides plumosa*, O. F. M. *b*. Muscles of the setigerous region. *p*. Papillæ of the skin.

side to supply the ventral longitudinal muscles and the surface. The nerve-cells in the ganglion stain deeply and are very distinct in the ventral median line, and in a lateral area on each side. Externally to the nerve-area are the circular muscular coat, the basement layers, hypoderm, and cuticle. The blood in spirit-preparations is red. In *Stylarioides moniliferus* it is pale (green in life). A heart-body is present anteriorly. A feature of moment is the occurrence of a symmetrical thickening of the ventral wall of the alimentary canal in the anterior region, the massive median area on each side of a central groove thinning off laterally. The great size of the perivisceral cavity in such types is noteworthy. The sandy mud in the interior of the gut is rich in diatoms, sponge-spicules, radiolarians, and organic *débris*. The posterior alimentary apparatus is in marked contrast, from its delicacy, with the condition of the organ in such as *Ophelia limacina*. The mesentery encloses the intestinal loop in the anterior dorsal region with the ovaries or spermaries.

In *Flabelligera affinis* the thin body-wall has the translucent cuticle crowded with the filamentous papillæ ending in clavate extremities. Beneath is a hypoderm so attenuate as to be almost indistinguishable. A tough, though thin, basement-layer follows with a few circular muscular fibres. The dorsal and ventral longitudinal muscles are thinly spread

out. No distinct view of the nerve-cords was obtainable in these sections, though they are readily seen in ordinary dissections under a lens in the normal position. The epithelial coat of the alimentary canal of this species also presented special thickening. In a female the large ova were confined within a delicate sheath, which likewise enveloped sections of the gut. The food consists of the same rich mud as in other forms.

Claparède (1873) observes that it is impossible to separate the longitudinal muscular layer of *Stylarioides moniliferus* into sections, and the cuticle is very tough. In this species the nerve-trunks lie in the cœlomic cavity, and are only lightly attached to the ventral wall. These annelids retract their branchial apparatus within the body-cavity.

The name *Siphonostomum* had been used for a parasitic crustacean, whilst *Pherusa* was applied by Leach to one of the Gammaridæ. The term Chloræmidæ is therefore more appropriate.

Cuvier (1817) included *Siphostoma*, Otto, amongst his Tubicolæ, and it was followed by the mollusk *Dentalium*. He was somewhat doubtful of the description of the double mouth by Otto, "the first smaller and canaliculated at the base, with an anterior part in the form of a proboscis, and the second much broader and more rounded behind." There is no double mouth, but it is possible that the author misinterpreted the folds of the region into which the mouth is retracted.

De Blainville (1828) gave *Siphostoma* a place under his family Nereiscolecia, a group including diverse forms.

Grube (1851) established the family Pherusea for this group, which he placed under his Limivora, following the Opheliacea, and in front of the Chætopteridæ. In his Philippine Annelids (1878) he uses Chlorhæmina, De Quatrefages, as the title of the family, and gives a revised note of the characters.

Dr. T. Williams (1858) thought the membranous sac attached to the ciliated and tubular segmental organ only a receptacle for the ova, and not an ovary. The segmental organs are limited to a few of the thoracic segments, and consist of a series of primary and secondary tubes linked together in a remarkable manner, and having attached to them fimbriated masses into which the ova or sperms are discharged. Each loop, he states, is a representative of a segmental organ. No special distribution of the green blood-system occurs in connection with these structures.

De Quatrefages (1865) placed the Chloræmidæ between the Cirratulidæ and the Nereidæ, and his previous memoir on the group had familiarised him with their chief structural features. The arrangement of the processes on the head and anterior region reminded him of certain Sabellids. With the exception of his genus *Lophiocephalus*, the feet are biramous. The digestive system is complicated by a series of pouches, which perform, he thinks, the functions of veritable stomachs. The blood is green. He was of opinion that they linked the Errant to the Sedentary annelids. This author arranged them as follows:

Body covered with papillæ, *Chloræma*.

Body without papillæ or with small papillæ.

Head protected by long bristles; all the feet biramous. Head very distinct, *Siphonostoma*. Head indistinct, *Pherusa*. Only the first pair of feet biramous, *Lophiocephalus*. Head entirely concealed, *Brada*.

Dr. Johnston (1865) formed the family Siphonostomaceæ for this group, but he had only two species under it, viz. *Siphonostoma uncinata* and *Trophonia plumosa*.

Kinberg[1] (1866) placed his Chloræmea between the Anthostomea (Ariciidæ) and Chætopterea, but adds nothing in regard to the family characters.

M. Sars[2] (1868) found four members of this family at considerable depths, viz. *Chloræma pellucidum*, at 200 fathoms; *Trophonia pallida*, *T. pilosa*, and *T. flabellata*, at 300 fathoms.

In the Chloræmidæ, Ray Lankester[3] (1873) mentions that "hæmoglobin is replaced in their blood by a body having similar properties, giving a dark red colour to the vascular fluid when seen in sufficient thickness, and a bright green in thinner layers. This body gave a very sharply-marked and characteristic pair of absorption bands in the oxidised condition, which were changed to a single one in the reduced condition, as in the case of hæmoglobin, the bands, however, having a relative intensity and a position altogether differing from those of hæmoglobin." After further chemical treatment this body, to which the name of Chlorocruorin was given, furnished two absorption-bands identical with hæmoglobin when similarly treated.

Grube, in 1878,[4] gave a further account of this family, its general structure, nomenclature, as well as the position assigned to it by various authors, and a perusal of this suffices to show the confusion which had crept into the nomenclature and classification of the group. He mentions the occurrence of the green blood, the general characters of the bristles and hooks, the condition of the anterior region, the alimentary canal, blood-vessels, and other internal organs. After a critical summary of the names of the family, he classifies them thus:

A. The bristles of the first and generally of the second and third segments straight, directed forward, and stronger and longer than the others. *Siphonostonum*, *Flabelligera*, *Trophonia*, *Piromis*.

(*a*) The skin beset with long and slender papillæ. *Siphonostonum*, Otto.

(*b*) The skin with shorter, wrinkled papillæ, and the bristles often longer and like crotchets. *Flabelligera*, *Stylarioides*, *Trophonia*.

B. The bristles of the first and the second segment hair-like, and little different from the rest. *Brada*.

Then follow the species under the various genera, chiefly differentiated by the condition of the bristles, but also of the neck-plate, branchiæ, and other features.

Th. Studer[5] (1878) figures a section of the body-wall of *Brada mamillata* from Kerguelen, but no ventral longitudinal muscles are shown, though they are mentioned in the description.

The Chloræmidæ, according to Levinsen[6] (1883), were, with a question, grouped under the *Syllidiformia Spionina*, apparently because no other position could be found for them. He places the genera thus: *Flabelligera*, *Trophonia*, and *Brada*.

[1] 'Öfversigt Kongl. Vet.-Akad. Förhandl.,' 1866, p. 337.
[2] 'Videnskab.-Selsk. Forhandl.,' 1868 (sep. copy), p. 10.
[3] 'Proc. Roy. Soc.,' vol. xxi, 1873, p. 2.
[4] 'Jahrb. Schles. Gesellsch. für Vaterl. Cultur,' 1877, t. lv.
[5] 'Arch. f. Naturges.,' Bd. xliv, 1878, p. 111, pl. v, fig. 8.
[6] *Op. cit.*, p. 180.

Horst[1] (1885) returned to the structure of the problematical organ which Otto had considered a second œsophagus, and Delle Chiaje a diverticulum of the stomach, but which most authors, *e.g.* Dujardin, Costa, Max Müller, Rathke, and De Quatrefages, had diagnosed as a blood-vessel. Claparède,[2] however, differed, and considered it a gland which opened into the buccal cavity, as Studer also thought. Horst was of opinion that it was a heart and heart-body, such as is found in the sedentary forms, *Cirratulus*, *Terebella*, and *Terebellides*.

Joyeux-Laffuie[3] (1887) stated that in *Chloræma Dujardini*, which occurs at Lac-sur-Mer on the spaces between the spines of the purple sea-urchin, the long papillæ are not tactile, since they have no nerve-supply; that the tentacles (2) are divided by a septum into two chambers, which communicate distally, and probably aid in respiration. The ciliated groove externally leads to the mouth. The eye is formed by the fusion of four simple eyes. He mentions five pairs of ovaries or of testes, but does not allude to the nephridia.

Cunningham[4] (1888) states that a neural canal exists in each cord at the inner side dorsally. The same author and Ramage[5] give an account of the vascular system, the nephridia, and the gonads.

Marenzeller (Fauna, Spitzbergen, 1889) states that Delle Chiaje gave the name *Stylarioides* in 1829; then followed Audouin and Edwards with *Trophonia* in 1834 (Hist. Nat. Litt. de la France): Savigny's genus *Aristenia* is synonymous. In 1841 Delle Chiaje placed *Trophonia barbata*, Aud. and Ed. as a synonym of his *Stylarioides moniliferus*. *Trophonia* thus lapses.

Bles[6] (1892) notes that in *Flabelligera diplochaitos* the external investment is soluble in 5—10 *per cent.* of sodium carbonate, but that the older internal layers (colloid) are not. The thin-walled stomach is continued into an S-shaped duodenum, all which, with the hinder end of the nephridia and the posterior ovaries in the female, are enclosed in the septum between segments of 9—10, and which confines the free genital products anteriorly. He confirms Horst's view as to the nature of the large contractile heart with its heart-body, as occurs in various groups of Annelids, and he believes that the cells of the heart-body are peritoneal in origin. The author describes the nephrostome in this species as situated at the hind end of the supra-œsophageal ganglion. It leads into a tube passing as far back as the twelfth segment, then curves and runs straight forward to the first bundles of bristles, where it opens on a cervical papilla close to the protuberance bearing the eyes. The two limbs of the tube are closely applied during their whole length, and somewhat resemble the thoracic nephridia in the Serpulidæ. He thought the Chloræmida were modified Tubiculous annelids.

De St. Joseph (1898) gives, after Marenzeller, the following classification:

(1) Dorsal and ventral bristles capillary.

[1] 'Zool. Anzeiger,' 1885, p. 12.
[2] 'Annél. Golfe Nap.,' 2 p., p. 102.
[3] 'Compt. Rend. Acad. Sc.,' Paris, t. civ, p. 1377.
[4] 'Quart. Journ. Micr. Sci.,' vol. xxviii, N.S., p. 273.
[5] 'Trans. Roy. Soc. Edinb.,' vol. xxxiii, pp. 674–676.
[6] 'Rep. Brit. Assoc.' for 1891, p. 373.

(*a*) Eight branchiæ, of which four are large and four small, situated behind the mouth and behind the tentacles.

Trophonia glauca, Malmgren; *Trophonia hirsuta*, Hansen; *Stylarioides longisetosa*, Marenzeller.

(*b*) Branchiæ ?

Trophonia Kerguelarum, Grube; *Trophonia Wyrillei*, McI.

(2) Dorsal bristles capillary, ventral forming simple hooks.

(*a*) 8—10 branchiæ, disposed as in the former group.

Stylarioides plumosa, O. F. Müller (includ. *Trophonia arctica*, Hansen? *T. borealis*, Hansen? and *T. rugosa*, Hansen, according to Levinsen). *Trophonia affinis*, Verrill; *Stylarioides tenera*, Grube; *Trophonia flabellata*, Sars; *Stylarioides cinctus*, Haswell.

(*b*) Brachiæ numerous, of equal size, supported by a membranous plate placed vertically behind the tentacles and the mouth.

Siphonostomum cariboum, Grube (S. *cingulalim*, Grube and Œrsted); *Stylarioides rudis*, Grube; *Trophonia capensis*, McI.

(*c*) Branchiæ ?

Stylarioides scutiger, Ehlers, Florida? *Stylorioides Horslii*, Haswell.

(3) Dorsal bristles capillary, ventral bifid.

(*a*) Branchiæ arranged in a horse-shoe.

Trophonia eruca, Claparède.

(*b*) Branchiæ numerous.

Trophonia arenosa, Webster.

(4) Dorsal bristles capillary, ventral articulated to a certain extent. Branchiæ?

Stylarioides collarifer, Ehlers, Florida.

(5) Dorsal bristles capillary; ventral bristles, some capillary or little thickened, the others forming hooks more or less stout.

Trophonia xanthotricha, Schmarda.

Mesnil[1] (1899) briefly considers the systematic position of the Flabelligeriens, De St. Joseph (Chlorémiens, De Quatrefages), and is inclined to link them on to the genera *Macrochæta*, Grube, *Acrocirrus*, Grube, and *Ledon*, Webster and Benedict. He relies on the nature of the prostomium with its palpi in the last named, the cylindrical branchiæ of the metastomium, the capillary dorsal bristles, and the large compound ventral bristles, the presence of a cardiac body, a pair of anterior nephridia, and the presence of papillæ. He thinks, therefore, that they may thus be linked on to the Cirratulidæ. Further, he is inclined to consider that they have certain affinities with the Sternaspidæ. He, however, does not allude to the absence of those transverse bars in the bristles, a feature so characteristic of the Chloræmidæ.

No British form presents so peculiar a branchial apparatus, for instance, as *Coppingeria*, from Port Molle, Queensland, described by Prof. Haswell.[2] In this form the stems of the bifid branchial apparatus have filaments to the number of sixty in each. The author holds that the papillæ on the surface are sensory. He devotes considerable

[1] 'Zool. Anzeiger,' Bd. xxii, p. 81, 2 text-figs.

[2] 'Proc. Linn. Soc. N. S. Wales,' 1892, vol. vi, p. 329, pl. xxvi, figs. 1—5, and other forms in pls. xxvii and xxviii.

attention to the cardiac body in the dorsal vessel in front in various Chloræmidæ. The nephridia in *Coppingeria* are of large size and extend from the posterior part of the prostomium backward to the two or three or more following segments in the dorsal region. Their ducts meet in front below the œsophagus, and the median duct opens in front—probably ventrally on or near the prostomium. He describes two pairs of eyes on a lobe between the branchiæ in *Coppingeria*, and they are more prominent than in *S. affinis*, his figures of the structure of both being drawn with the author's usual care.

Paton[1] (1899) found a lumen in the heart-body of *Flabelligera*, which Cunningham did not see. He also met with crystalline calculi in the cœlom, as Jourdan had previously done in the mesenteries. As Bles observed, the anterior pair of nephridia had no blood-vessels. It is possible either they or the reddish-brown pigment of the gills may aid in excretions from the blood.

The Chloræmidæ occur between tide-marks in muddy fissures of rocks and shale, or on muddy ground in deeper water, and some go to great depths, like the comparatively large *Buskiella abyssorum* of the 'Challenger,' which frequents the 2500 fathom line. Their distribution is cosmopolitan.

Though their coloration is, as a rule, not striking, yet the iridescence of their long bristles and the hues of their branchiæ and tentacles are not without beauty.

Genus XCI.—STYLARIOIDES, *Delle Chiaje*, 1829.[2]

Trophonia, Audouin and Edwards; *Pherusa*,[3] (Oken) De Blainville; *Lophiocephalus*, Costa; *Siphonostomum*, Otto.

Cephalic and anterior region retractile (forming a kind of siphon, containing the mouth) and, in general, trilobate. Behind the mouth are two large tentacles (palpi) at the base of a membranous peduncle supporting numerous branchiæ disposed as in the Serpulidæ, but in parallel rows. Body in general long, enlarged anteriorly, slightly attenuate posteriorly. Papillæ few and small. Branchiæ filiform, fixed to the anterior margin of the buccal segment. Bristles of the first two or three segments long, strong, straight, few, iridescent, and directed forward in the form of a cage for the cephalic region. Dorsal bristles of the succeeding segments fine, few in number; ventral in the form of crotchets.

De St. Joseph (1898) also adopted Delle Chiaje's title—Stylarioides—for this genus, and he made the following groups: (1) In which both dorsal and ventral bristles are slender, and with eight branchiæ, four large and four small, arising behind the mouth, *e.g. S. glauca* and *S. hirsuta*. (2) Dorsal bristles slender, ventral in the form of hooks; eight or ten branchiæ as in the first group, *e.g. S. flabellata*. (3) Dorsal bristles slender, ventral recurved, with a sub-rostral spine; branchiæ numerous; *S. arenosa*. His fourth and fifth groups contain no British form.

[1] 'Quart. Journ. Micr. Sci.,' vol. xli, N.S., p. 283, pl. xxi, figs. 23, 26, and 34.

[2] 'Memorie,' vol. iv, p. 178; 'Descrizione,' vol. iii, p. 75.

[3] This title was used for a crustacean by Leach in 1815, and for a polyp by Lamouroux in 1816.

1. Stylarioides plumosa, *O. F. Müller*, 1776. Plate LXXXIX, fig. 1; Plate XCV, figs. 11—11 *b*—papillæ of surface; Plate CIV, figs. 1—1 *d*—bristles and hooks; Plate XCVI, figs. 1 and 1 *a*—segments and branchia.

Specific Characters.—Body greyish-brown, more or less clavate, reaching 5 inches or more in length. Convex on both surfaces, though slightly flattened ventrally. Segments sixty to seventy, and of a single ring. Surface rugose with papillæ, which are elongated on the dorsum and largest anteriorly, and often with grains of sand attached. Two large crenated palpi of a rose-pink lustre, and above them are eight or ten grass-green branchiæ. The first three segments have very long, resplendent, articulated bristles directed forward, the longest being the first. The fourth segment has a shorter dorsal tuft of the same kind of bristles, ventrally articulated spines with a double curve, and soon the typical single hook occurs ventrally throughout the rest of the body, viz. a stout crotchet with a curved golden tip and fine transverse striations which pass considerably beyond the opaque central obliquely striated region. Posteriorly the vent is surrounded by a ring of surface-papillæ. Single pair of nephridia opening anteriorly. Two pairs of gonads in front.

Synonyms.

1776. *Amphitrite plumosa,* O. F. Müller. Prod. Zool. Danica, p. 216, No. 2621.
1780. „ „ O. Fabricius. Fauna Grœnl., p. 288, n. 271.
1789. „ „ Abildgaard. Zool. Danica, vol. iii, p. 16, Tab. xc, f. 1—2.
1791. „ „ Gmelin. Linn. Syst. Nat., ed. 13, t. i, p. 3112.
1802. „ „ Turton's Linnæus, iv, p. 83.
1815. *Pherusa Mülleri,* Oken. Lehrb. Zool., iii, p. 377.
1820. *Amphitrite plumosa,* Savigny. Syst. Annel., p. 91.
1828. *Pherusa Mülleri,* Blainville. Dict. Sc. Nat., t. lvii, p. 440.
1829. *Flabelligera plumosa,* Sars. Bidrag. Söedyr. Nat., p. 32.
1832. *Flemingia muricata,* Johnston. Trans. Berw. Club, i, p. 15.
1840. *Trophonia Goodsiri,* idem. Ann. Nat. Hist., vol. iv, p. 371, pl. xi, f. 1—10.
„ *Pherusa plumosa,* Œrsted. Reg. Mar., p. 79.
1842. *Siphonostoma plumosum,* Rathke. Neuste Schrift. Naturforsch. Gesell. in Danzig, Bd. iii, p. 84, Taf. vi, figs. 1—7.
„ *Siphonostomum plumosum,* idem. Beitr. zur. vergl. Anat. u. Physiol. Reibsebemerk. Danzig., p. 84, pl. vi.
1843. *Siphonostoma plumosa,* idem. Nova Acta Acad. Leop.-Car., xx, p. 208, Tab. ii, f. 1—2.
1844. *Trophonia Goodsiri,* W. Thompson. Ann. Nat. Hist., vol. xiii, p. 437.
1845. *Siphonostoma plumosa,* von Siebold. Ray Soc. Reports on Zool. for 1842, p. 283.
1846. *Trophonia Goodsiri,* Johnston. Ann. Nat. Hist., vol. xvii, p. 294.
1847. *Siphonostoma plumosa,* von Siebold. Ray Soc. Reports on Zool. for 1844, p. 508.
1848. *Trophonia barbata,* M. Edwards. Cuvier's Règ. Anim., Disciples' ed., Annel., p. 46, pl. xxii, figs. 1—1 *b*.
1849. *Pherusa Goodsiri,* De Quatrefages. Ann. Sc. nat., 3e sér., t. xii, p. 290, pl. ix, figs. 15—18.
„ „ *obscura,* idem. Ibid., 3e sér., t. xii, p. 289, pl. ix, figs. 15—18.
„ „ *Müllerii,* idem. Ibid., p. 291.
1851. *Siphonostoma plumosum,* Grube. Fam. Annel., pp. 73 and 136.
„ „ „ Sars. Nyt Mag. f. Naturvid., Bd. vi, pp. 132 and 206.

1853. *Pherusa Mülleri,* Dalyell. Pow. Creat., vol. ii, p. 257, pl. xviii, figs. 5—9.
1857. *Siphonostoma plumosum,* Koren. Nyt Mag. f. Naturvid., ix, p. 94.
1859. *Siphonostomum plumosum,* Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 120.
1861. ,, ,, idem. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 53.
1864. ,, ,, Kölliker. Würzb. Natur. wiss. Zeitschr., Bd. v, p. 248, pl. vi, fig. 7 (papillæ).
,, ,, ,, idem. Kurzer Bericht, pp. 10 and 17.
1865. *Trophonia plumosa,* Johnston. Cat. Worms Brit. Mus., p. 224.
1865. *Pherusa Mülleri,* De Quatrefages. Annel., i, p. 482.
,, ,, *Goodsiri,* idem. Ibid., p. 481.
,, ,, *obscura,* idem. Ibid., p. 479, pl. xii, fig. 7.
1867. *Trophonia plumosa,* Malmgren. Annul. Polych., p. 82.
1869. ,, ,, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 419.
,, *Siphonostomum plumosum,* Grube. Mitt. St. Vaast, p. 37.
1873. *Trophonia plumosa,* Sars. Bidrag. Christ. Fauna, No. 3, p. 47.
,, ,, ,, idem. Nyt Mag. f. Naturvid., p. 247.
1874. ,, ,, McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 201.
1875. ,, ,, idem. Invert. and Fishes St. Andrews, p. 125.
1877. ,, ,, Grube. Jahresb. Schles. Gesells. für 1876 (sep. abdr.), p. 49.
1878. *Siphonostomum plumosum,* McIntosh. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 506.
1879. *Trophonia plumosa,* Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 52.
,, ,, ,, Tauber. Annul. Danica, p. 111.
1881. ,, ,, Leslie and Herdman. Proc. Roy. Phys. Soc. Edinb., vol. vi, p. 66.
,, ,, *hirsuta,* Hansen. Norske Nordh.-Exped., vol. vii, Annel., p. 38, Taf. vii, figs. 5—8.
,, ,, *borealis,* idem. Ibid., p. 38, Taf. vii, figs. 13—16.
,, ,, *arctica,* idem. Ibid., p. 39, Taf. vii, fig. 17—20.
1883. *Trophonia plumosa,* Levinsen. Nord. Annel., Vidensk. Meddel. Foren. Kjöbenh., p. 122.
1887. ,, ,, Wirén. Köngl. svenska Vet.-Akad. Handl., Bd. xxii, pp. 11, 21, 42, pl. ii, figs. 3, 5, 7; pl. iii, figs. 2, 6, 7; pl. iv, figs. 6—7; pl. v, figs. 15—16.
1888. ,, ,, Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 674, pl. xlvi, fig. 39.
,, ,, ,, Cunningham. Quart. Journ. Micr. Sci., vol. xxviii, N.S., pp. 260, 262, pl. xix, figs. 17—19.
1891. ,, ,, Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 256.
1894. *Stylarioides plumosus,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 101, pl. v, fig. 125.
,, *Trophonia plumosa,* Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 104.
1897. *Stylarioides plumosus,* Michaelsen. Polych. deutsch. Meere, p. 149.
1898. ,, ,, De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 367, pl. xxi, fig. 180.
1904. ,, (*Trophonia*) *plumosa,* Journ. M. B. A., vol. vii, p. 231.
1906. ,, *plumosus,* Bohn. Ann. Sc. nat., 9e sér., t. iii, p. 120 (movements).
1907. ,, *plumosa,* Fauvel. Bull. Inst. Ocean., No. 107, p. 20.
1908. ,, ,, McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 529, 540, 541.
1909. ,, ,, Fauvel. Bull. Inst. Ocean., No. 142, p. 6.
1910. ,, *plumosus,* Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 240.
1914. ,, ,, idem. Ibid., vol. xxxi, pt. 47, p. 137.

Habitat.—Abounds between the layers of shale and laminated sandstone at the East and other rocks at St. Andrews. It delights in dark odoriferous mud, along with the little

Lima and mussels in the West Voe of Scalloway, Shetland. At Lochmaddy it occurs under stones near low-water mark. Fine examples come from Bressay Sound. Stomach of the cod and haddock, St. Andrews Bay (E. McIntosh). Montrose Bay (Dr. Howden); Firth of Forth (Leslie and Herdman); Plymouth (Allen); Dublin Bay and Clare Island (Southern).

Abroad it ranges to Norway (H. Rathke, A. M. Norman); Finmark (A. M. Norman); Atlantic coast, U.S.A. (Verrill).

Generally distributed in the Northern seas and extending to Greenland and the American shores.

Anterior end.—The prostomium appears to be entirely hidden in the adult. Above the papillose opening of the mouth are two large crenated palpi which superiorly have a rose-pink lustre, probably from the iridescence of the cuticle. The frills occur on the edges of a deep groove which lies on their ventral surface. Each palpus appears to have a greenish central vessel, which is much paler than the branchial trunk, and when they emerge they appear to be slightly folded as well as contracted. Above the palpi are the grass-green branchiæ, which are eight or ten in number, each with an afferent and an efferent vessel, and having external circular and internal longitudinal muscular fibres with hypoderm and ciliated cuticle. Both palpi and branchiæ are capable of considerable elongation. In an example from Montrose Bay, forwarded long ago by the late Dr. Howden, one of the left branchiæ (Plate XCVI, fig. 1 *a*) showed a small spur near the tip, thus forming a bifid organ. As this process arose from a slight hollow in the outline of the branchia it may have sprung from the site of an injury.

Body reaching 5 in. or more in length, convex on both surfaces, though having a tendency to ventral flattening anteriorly and more especially posteriorly. Its calibre varies according to circumstances, but it is generally somewhat larger anteriorly and tapers gently to a blunt tail posteriorly. Most of the well-preserved spirit-specimens show an enlargement in the anterior third and an abrupt diminution at the snout. The segments range from sixty to seventy-nine, the larger examples having more segments than the smaller, and they have only a single ring. The whole surface, with the exception of the grooves indicating the segments, is rugose with papillæ, which are elongated on the dorsum and longest anteriorly, the ventral surface being distinguished by its shorter papillæ. These processes have externally a sheath of thickened epiderm, densest at the tip, beneath which is a pale extension of the skin composed of long, tough, pale fibres interwoven in all directions, which can be withdrawn from the former like a finger from a glove in slightly softened specimens. They are thus studded over the skin as structures shaped like nine-pins and have a central axis communicating with the hypoderm of the body-wall (Plate XCV, figs. 11—11 *b*). Beneath is another layer (muscular) less tough.

In more or less perfect examples the posterior end is slightly tapered to a blunt cone with the anus toward the centre, but many examples bear evidence of reproduction of this region, the vent being surrounded by a margin, and the papillæ of the surface forming a ring beyond it. When rupture occurs considerably in front of the anus the truncated end soon cicatrises, the papillæ of the surface being studded round the new anus in the centre, and at first on a very blunt cone. The dorsal bristles bend toward each other, whilst the hooks project boldly backward from the base of the cone. In such specimens the dorsal surface is deeply grooved for some distance in front of the cicatrised end. In what

appeared to be a perfect and large example from Lochmaddy, the anus formed a vertical slit nearer the ventral than the dorsal surface, and above it a parasitic crustacean, which unfortunately cannot now be found, was attached by a process.

The general colour is greyish-brown, darker on the dorsum, paler ventrally. Attached to the longer papillæ of the dorsum are numerous grains of sand, and some particles are firmly fixed to the skin between the papillæ. In the coarsely papillose region on the dorsum immediately behind the long anterior bristles, mud, Foraminifera, and sand-grains are frequently abundant. In badly preserved examples the cuticle readily separates from the subjacent hypoderm, carrying with it sand-grains and other adherent structures, and leaving acutely conical smooth papillæ on the skin beneath. Moreover, such specimens show a coarser papillose surface from the swollen condition of the papillæ.

The mouth is a vertical slit, below the palpi, with fleshy lips which slowly open and close in the continuous swallowing of water, and probably also of muddy sand as food, under ordinary conditions. The inner surface of the lips is pale reddish-brown. Rarely a hoof-shaped process with the flat surface pointing ventrally is thrust out, the anterior or dorsal arch having the eight branchiæ along its edge, whilst posteriorly are two external lateral processes, two small median below the transverse mouth, and a larger posterior or ventral process. On an eminence in the centre above the mouth are two brown pigment-spots representing the eyes.

The mouth leads into a cylindrical œsophagus about half an inch long, followed by a somewhat globular crop, then an elongated stomach with firm walls, coloured orange in some forms internally (Claparède), and nearly three-quarters of an inch long. From this the intestine is thrown into many coils supported by a thin mesentery, and from the mass the gut escapes on a level with the stomach and passes nearly straight backward, and by-and-by in the median line, to the tip of the tail. The crop has a translucent wall studded with single cells, groups of large nucleated cells, and caudate cells. The glands of the stomach are circular.

The intestine contains coarse sand-grains, sponge-spicules, fragments of the spines of *Spatangus*, Foraminifers, Radiolarians, elliptical bodies like spores, fragments of algæ, and other organic *débris* in mud.

The cœlom in this and allied forms (*S. monilifer*) presents behind the stomach a dark pyriform glandular tube, which adheres by its blind end to this organ. It has a pale muscular and vascular coat externally, and internally a coat of intensely black cells. It passes forward to the snout, where Otto describes an aperture. Delle Chiaje termed this organ "bourse-gastro-œsophagienne," and Otto a second œsophagus. Max Müller thought it was a blind vessel, and so did Costa. It is the heart and heart-body.

Two symmetrical white tubular glands (nephridia) also are present, and each terminates in a *cul-de-sac* on the coat of the stomach, while in front they are continued to the snout. They are filled with cells containing spherical bodies—it may be oxalate of lime. Kölliker thought that similar structures in *Flabelligera* resembled the kidneys of Gastropods. They are probably excretory and open by pores on the snout in *Siphonostoma* (Otto and Claparède). The two whitish nephridia were crowded in June with minute granules and innumerable spherules of opaque white oily bodies, apparently somewhat granular. The nephridiopores are quite at the anterior end.

The perivisceral cavity is divided into two parts by a vertical partition, as Otto found in *Flabelligera*.

The anterior opening in a partially contracted example is a vertical slit more or less widened in the centre according to circumstances, and having a frilled margin surrounded by an area with longer papillæ which form a fringe. On each side is a vertical ridge, slightly divided into a dorsal and a ventral division, and from each of these springs a remarkably long tuft of golden bristles (Plate LXXXIX, fig. 1), which stretch far in front of the animal and refract the light beautifully. All are boldly articulated, but not quite uniformly so, some, even in the same bristle, being broader than long, and others the reverse. The majority of the divisions seem to have a longer vertical than transverse diameter, though the larger bristles usually show shorter segments toward the base. These bristles gradually taper almost from the base to the finely pointed tip which has shorter articulations. Toward the base (in the tissues) the bristle is slightly narrowed, and the transverse articulations are closer and less regular, almost disappearing at the end (Plate CIV, fig. 1 *b*), and the inserted portion of each bristle is great, no less than a quarter of the length in the longer forms and more in the shorter. From the direction (upward and forward) of these bristles they could be of little use to the annelid on a flat surface, but they would act on the wall of a tube or tunnel, as well as protect the branchiæ and palpi. They are comparatively brittle. Numerous parasitic growths, such as pale Fungi, which stretch in a pinnate manner from the shaft and tip, thecate Infusoria, and Vorticellæ, abound on them. The next segment likewise has two long tufts of similar bristles, only they are somewhat shorter than the first; and so with the third segment, the bristles of the latter being considerably shorter than those of the second, especially the ventral group. The fourth segment inaugurates the condition present throughout the rest of the body, viz. a dorsal tuft of the resplendent tapering articulated bristles, now comparatively short, which spreads in a fan-like manner over the dorsum, and a ventral series of stout spines with a double curve. It occasionally happens that in a mutilated specimen some of these dorsal tufts in the middle of the body are abraded to a level with the skin. The base of the ventral hook is inserted deeply into the tissues and is boldly articulated, the free portion immediately beyond the skin being curved backward and more closely articulated or striated transversely, the striæ becoming even more closely arranged as the organ dilates distally, viz. about the termination of the opaque striated central region. The rest of the tip is pale, translucent, and curves slightly forward to the point. These hooks of the fourth segment have shafts (transversely striated) and longer flattened tips than those behind. Moreover, the elongated tip in some is scarcely bent. It is clear that this is only a modification of an articulated bristle, and leads the way to the typical hook (Plate CIV, figs. 1 *c* and 1 *d*), which has a shorter and more distinctly curved golden tip, the very fine transverse striations passing considerably beyond the opaque central obliquely striated region. The greater part of the shaft of the hook (more than two-thirds) is inserted in the tissues, so that the leverage is great, and the concavity of the hook is generally directed forward. Each segment has as a rule three or four of these hooks in transverse series at nearly equal distances, and they are latero-ventral in position, probably in connection with the habits of the species in its tunnel. In very large examples from Bressay Sound the first four feet had four hooks protruding externally,

the following segments for a considerable distance four or five, and then, as a rule—throughout more than the posterior third—three. These large forms, however, often had four projecting hooks in the posterior region, and the surface-papillæ were less affected by sand-particles. Each is accompanied by a short, finely-tapered bristle, the tip of which projects beyond the surface. The centre of each hook is opaque and striated—longitudinally in the shaft, obliquely in the distal or curved region. They are hard but also brittle, the extremity being frequently fractured. Though only three hooks protrude externally in each foot, several (three to five) are usually in process of development in the tissues. In these the tips are narrowed, whilst the basal portion is nearly twice as thick as that of the perfect hook. The slender curved tip appears first. The broad bases of these developing hooks strengthen the whole mass and render it stiff. Accompanying these are several developing forms with a very slender tip, or with a more distinctly hook-like extremity, which is less delicate than that figured.

Reproduction.—In a male on May 19th two long, frilled pale-pink testes, considerably longer than the ovaries in the female, stretched from the two white organs (nephridia) in front and in connection with the ventral vessel. They had only granular testis-cells with nucleus and nucleolus, so that the period of maturity is probably in June or July—it may be later. Both Delle Chiaje and Claparède observed the position of these organs, and the latter criticised Da Costa for erroneously supposing these annelids were hermaphrodite.

In the female the ovaries had the form of elongated lobose or frilled structures of a rich grass-green colour, and stretching from the white organs (nephridia) in front. The ova at this time (May 19th) were small, viz. from 0·076 mm. downward, with nucleus and nucleolus, and thus were far from maturity. The ovaries were permeated by numerous vascular twigs of the same greenish hue as the other vessels. Dalyell[1] observed an "ovarium, with deep grass-green ova" protruding from the body.

Small examples differ from adults in their less dilated anterior region, and in the smaller number of segments. Thus, specimens about an inch in length have from forty to forty-seven or forty-eight segments. They occur in the same regions as the larger forms.

Habits.—As a habitual inhabitant of a tube or tunnel in muddy sand, its habits are comparatively sluggish, and the modified and pulpy sandy mud in the neighbourhood of its tunnel seems to have undergone digestion. It rolls about in a vessel of sea-water, or lies quietly with its branchiæ and palpi extended, the latter being capable of great elongation. Yet the annelid can wriggle or swim through the water by jerks or contortions of the body. When the bristles anteriorly are touched it withdraws the branchiæ and palpi, as in many spirit-preparations—which alone were seen by Dr. Johnston. The presence of other annelids, such as Polynoidæ, in the vessel seem to cause it annoyance, since they cling to the anterior bristles and cause it to withdraw its branchiæ and palpi. Moreover, the *débris* in a collecting-bottle coats the bristles throughout, so that it seems to be best adapted for a life in a sandy or muddy tube. The long anterior bristles are spread out in a fan-like manner so as to form an arch over the delicate branchiæ and tentacles and act both as guards and sentinels. The moment these bristles are touched the branchiæ contract and disappear.

[1] 'Pow. Creat.,' 1853, vol. ii, p. 258, pl. xviii, fig. 9.

The *Stylarioides monilifera* of Delle Chiaje [1] (1829) appears from its description to be a closely allied form, but it is really a characteristically different species, for its long, slender body is smoother to the naked eye, its surface-papillæ being densely arranged and minute, and its bristles and hooks likewise diverge.

H. Rathke [2] (1842) gave a careful account of this species from spirit-preparations, correcting O. F. Müller's interpretation of the branchiæ (Rathke's cirri) which he described as ovaries. His figures of the external and internal structure are, on the whole, accurate.

Dr. Thos. Williams [3] (1852) in his Report considered that *Trophonia* was characterised (in contrast with *Lumbricus* and *Hirudo*) by a great increase in the perivisceral fluid, which performed the function of aëration. He did not interpret the greenish organs as branchiæ.

Dr. Johnston (1865) drew the conclusion that, from the softness and flaccidity of its body as well as from its structure, this form burrowed in the soil like *Arenicola*, yet most of the examples procured at St. Andrews have been found between the layers of shale and sandstone, but it delights in dark, odoriferous mud.

The confusion in regard to this species is well illustrated by a reference to De Quatrefages (1865), for it is described under three names with accompanying references. He also mingled *Brada* and *Siphonostoma* with *Pherusa* and thus increased the complexity of the subject.

Verrill [4] (1873) describes a new species (*Trophonia affinis*) from Vineyard Sound, U.S.A., which seems to approach the British form very closely.

Levinsen (1883) regarded the *Trophonia flabellata* of Tauber as a young example of *Stylarioides plumosa*, and he ranged the *T. arctica*, *T. borealis*, and *T. rugosa* of Hansen under the latter species.

In 1887 Wirén gave an account of the structure of this species as one of his limivorous polychætes. Excellent figures of the general anatomy accompanied the description.

Cunningham and Ramage (1888) describe the circulatory system and the heart-body in this species, as well as the structure of the single pair of nephridia in front. They could not find a nephrostome. They also mention the male and female gonads which occur in the seventh and eighth segments. The ovaries are green and the testes pale yellow. Cunningham [5] further describes a thin vessel (his homologue of the dorsal) running on the inner surface of the body-wall, receiving transverse vessels from the intestine, and opening into the dorsal side of the heart. The cardiac body he found to be composed of cylindrical cellular cords resembling nephridia. The blood contains small oval nucleated corpuscles.

The *Stylarioides hirsutus*, of Lo Bianco [6] (1893), would seem to approach this species. It is difficult to say what his *Brada parthenopeia* may be.

[1] 'Memorie,' vol. iv, p. 178, Tav. liii, fig. 5.
[2] 'Neuste Schrif. Naturforsch. Gesell. in Danzig,' Bd. iii, p. 86, Taf. iv, figs. 2 and 5.
[3] 'Rep. British Association' for 1851, pt. 1, p. 202.
[4] 'Rep. Fish. Comm. U.S.A.,' p. 605, pl. xiv, fig. 75.
[5] 'Quart. Journ. Micr. Sci.,' vol. xxviii, N.S., p. 260.
[6] 'Atti R. Accad. Sc. Nap.,' 2 ser., vol. v, No. 11, p. 42, Tav. ii, fig. 5, and Tav. iii, fig. 11.

De St. Joseph (1894) observes that this species is rare at Dinard, but careful search in fissures of rocks between tide-marks might lead to further captures.

Fauvel (1907) includes Hansen's *arctica*, *borealis*, and *rugosa* under this form.

2. Stylarioides glauca, *Malmgren*, 1867. Plate XCVI, fig. 2; Plate CIV, fig. 9—bristle.

Specific Characters.—Body somewhat clavate in outline, 1 to 1½ in. in length, slightly tapered anteriorly and much more so posteriorly, with clearly differentiated segments, the posterior region sometimes forming a narrow, moniliform appendage of many segments. General surface comparatively smooth under a lens, though studded with long clavate papillæ, and encrusted with minute particles of sand which give a dull greyish appearance in life and in a state of preservation, with a dull bluish region from the intestine. Body-wall thinner than in *S. plumosa*, and the fascicles of dorsal and ventral longitudinal muscles are visible as separate strands. Palpi flattened and crenate. Six branchial processes, the two lower with filiform tips and no pale streak in the centre. Two minute brown pigment-specks on the process bearing branchiæ, palpi and mouth. Frontal bristles (first series only) translucent, pale, iridescent and few in number in contrast with *S. plumosa*, boldly articulated. Second series inaugurate the arrangement throughout the rest of the body, viz. a longer dorsal tuft of articulated bristles and ventrally a shorter yet conspicuous tuft proportionally thicker, also with well-marked articulations and a tapered and slightly hooked tip.

Synonyms.

1867. *Trophonia glauca*, Malmgren. Annul. Polychæt., p. 82, Tab. xiii, fig. 78.
1869. „ „ McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 419, pl. xv, fig. 13 *b*.
1873. „ „ Sars. Bidrag Christ. Fauna, No. 3, p. 48.
1875. „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 24.
1877. „ „ Grube. Abh. Schles. Gesellsch. Nat. (1876), p. 49.
1879. „ „ Tauber. Annul. Danica, p. 112.
1881. „ „ Leslie and Herdman. Proc. Roy. Phys. Soc. Edinb., vol. vi, p. 66.
1883. „ „ Levinsen. Vidensk. Medell. Foren. Kjöbenh., p. 122.
1894. „ „ Bidenkap. Christ. Vet.-Akad. Forhandl., p. 104.
1897. *Stylarioides glaucus*, Michaelsen. Polych. deutsch. Meere, p. 158.
1900. *Trophonia glauca*, Newbigin. Millport Communic., i, p. 5.
1907. *Stylarioides glauca*, Fauvel. Bull. Inst. Ocean., No. 107, p. 21.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 530 and 541.
1910. „ *glaucus*, Southern. Proc. R. Irish Acad., vol. xxviii, p. 240.
1914. „ „ Idem. Ibid., vol. xxxi, pt. 47, p. 137.

Habitat.—Dredged in considerable numbers in St. Magnus Bay in 100 fathoms; Outer Haaf, Skerries, in 70—80 fathoms; off the Hebrides (1866), and also off Inverary (J. G. Jeffreys); 50 fathoms in Dingle Bay (J. G. J.); 18 fathoms south of Bressey Sound (W. C. M.); Hillswick Harbour in a sponge at low water (J. G. J.); off St. Abbs' Head (Leslie and Herdman); off Bailey Light, Dublin Bay, and Clare Island (Southern); S.W. Ireland, Stat. II, 110—120 fathoms; Bantry Bay; and Kenmare (R. I. A.). In the 'Porcupine' Expedition of 1869, and in that of 1870, at 358 fathoms, on sand, Lat.

48° 26′ N., Long. 9° 44′ W. (Stat. VI); and at Stat. VIII, 257 fathoms, on sand, Lat. 48° 18′ N., Long. 9° 11′ W.

It is common off Sweden (Lovén, Ljungman, Malmgren); Norway (Canon Norman); Denmark, Atlantic (Fauvel).

This species is characterised by its smaller size, 1—1¼ in.; smoother outline, shorter and finer bristles, and more distinctly differentiated segments posteriorly. The body is somewhat clavate in outline, slightly tapered anteriorly, and more distinctly attenuated posteriorly, indeed in some preparations the posterior region forms a narrow, moniliform appendage of about forty segments. In the majority, however, the tail is imperfect, but in a few it tapers to a somewhat blunt cone with the anus in the centre. The body-wall is considerably thinner than in *S. plumosa*, and the entire animal more delicate. In one or two in which the posterior end had been lost a dilatation of two segments occurred in front of the tail, and then followed a short conical region composed of the reproduced tail. The general surface of the body is much smoother under a lens than in *S. plumosa*, yet it is studded with long, clavate, and other papillæ (Plate XCVI, fig. 2), and encrusted with minute particles of sand, which give a peculiar dull greyish sheen to the species; indeed, in spirit, it retains very much the aspect in life, viz. light grey, with a dull bluish region dorsally from the intestine. As in *S. plumosa*, the fascicles of both dorsal and ventral longitudinal muscles are visible as separate bands through the integument in the preparations.

The palpi are finely crenate, flattened, grooved organs—differing in appearance from those of *S. plumosa*. Above there are six processes, four in the preparations rather broad and grooved, and two with filiform tips. Thus Malmgren's artist, after all, correctly represented the number, though somewhat imperfectly figuring the palpi. In the text Malmgren corrects the figure, which he states shows four palpi. If all the six above the palpi are branchiæ, the difference in form of the two lower with the filiform tips is interesting, for they have no pale streak in the centre. The branchiæ in *Stylarioides plumosa* have only an opaque band in the centre—probably from the blood-vessels. In this species a similar basal process to that in *S. plumosa* bears the branchiæ and palpi, but the two minute brown pigment-specks on the ventral surface are wide apart.

The majority show only a few of the long anterior bristles which stretch forward from the first body-segment immediately behind the smooth process which projects from the anterior aperture. These are proportionately short and delicate when contrasted with those of *S. plumosa*, as well as few in number, indeed, in many of the specimens collected in diverse localities they are absent. The translucency of these pale iridescent bristles causes the joints to become very distinct, so that the bristle resembles the stalk of a Conferva (Plate CIV, fig. 9, frontal bristle). The segments are longer than in the bristles of *S. plumosa* (*Ibid.*, fig. 1 *b*). The ventral bristles form a short, but yet conspicuous, tuft below and a little behind the foregoing in the segment. They are short and proportionally thick, with well-marked articulations, and only slightly taper toward the tip, which is distinctly hooked. The succeeding bristles are arranged in a dorsal and a ventral tuft, and both are capillary and articulated, the inferior, however, being shorter and having proportionally longer joints. In proportion to the size of the annelid these

bristles posteriorly are fairly conspicuous; indeed, in some this fringe to the caudal segments is more evident than in the majority of the specimens of *S. plumosa*, since the dorsal bristles form a fan.

Reproduction.—In examples from St. Magnus Bay, and also from Dingle Bay, in July, large ova occurred anteriorly, and apparently were ovarian, since many had a stalk or process attached.

Fauvel (1907) considers the *Trophonia hirsuta* of Hansen as identical with this form, while Miss Newbigin (1900) thinks them distinct.

3. Stylarioides arenosa, *Webster*, 1879. Plate XCVI, fig. 3; Plate CIV, figs. 6—6 *d*.

Specific Characters.—Palpi grooved and crenate; branchiæ numerous (Webster says "red at base, green externally"). Body about 2 in. in length, firm and more or less rounded from a dense coating of adherent sand-grains, and in the preparations grooved anteriorly, either dorsally or ventrally, from contraction, slightly tapered anteriorly, and gently diminished to a blunt tail, with the anus in the middle. Segments distinct, 60—70. First three sets of articulated bristles longer than the rest, and with the next two directed forward, shorter than in *S. plumosa*, more slender, pale yellow, and resplendent. Ventral of the third series shows a hooked tip with an adnate secondary process, and in its progress backward the edge of the latter is differentiated into a separate process, either by use or otherwise, and the whole flattened hook becomes shorter and more densely articulated.

Synonyms.

1879. *Trophonia arenosa*, Webster. Trans. Albany Instit., vol. ix, p. 45 (sep. copy), pl. vii, figs. 92—97.

1908. *Stylarioides arenosa*, McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, p. 531.

Habitat.—At low water-mark, St. Peter Port, Guernsey, July, 1868.

It was first found between tide-marks, Northampton County, eastern shore of Virginia (H. E. Webster).

Branchiæ six to eight or nine in number; tips pale in the preparation, then with a reddish-brown bar followed by a pale base. Webster states "branchiæ very numerous, filiform, red at base, green externally; the inferior shorter than the superior."

According to Webster, the "tentacles are not quite so long as the branchiæ, canaliculated margin scolloped; colour reddish-brown with a green centre."

Body (Plate XCVI, fig. 3) rounded, about two inches in length, enlarged anteriorly, but less bulbous than *S. plumosa*, diminished a little in front and tapering posteriorly to a blunt tail. Segments sixty-two to seventy. It is distinguished by its somewhat firm consistence and a tendency to have a groove either ventrally or dorsally anteriorly, as well as by its dense coating of sand-grains. The segments are distinctly marked from the first to the last, and, in so far as the first three and to a less extent the following two sets of bristles are directed forward, the resemblance to *S. plumosa* is greater than to

S. glauca, yet the bristles are distinctly shorter and paler. The entire surface is closely beset with sand-grains so that to the touch it resembles a hard sandy tube. The papillæ seem to be more or less cylindrical with a clavate tip, but they exhibit no evident arrangement in rows as in Mr. Webster's American form. The anus is situated in the centre of the somewhat blunt tail.

As mentioned by Mr. Webster, the bristles of the first five segments point forward, but the first three are most conspicuous. The first set is the longest, and its bristles are densely coated with various growths such as thecate Infusoria, algæ, mud and fragments of bristles. The ventral are a little shorter than the dorsal. Though pale by reflected light these bristles are brownish by transmitted light, taper to a very delicate hair-like tip, and have a series of articulations which are closer at the base, longer in the diminishing tip (Plate CIV, figs. 6 and 6′, 6 *b*, 6 *b*′). The ventral of the second series are considerably shorter, have a dorsal curve, and taper to a less delicate though simple tip which is slightly hooked. The ventral of the third series (Webster says fourth) consist of three bristles curved at the tip and bifid, the tips indeed resembling those of *Sigalion* and *Sthenelais*. The terminal segment (Plate CIV, fig. 6 *c*) is about three or four times as long as the adjoining, and ends in a hook, with a secondary process in the form of a fixed band beneath (that is in the concavity). Whilst only three project externally seven occur in the tissues, but four are imperfectly developed. The bases of these bristles form an even row. Of the three projecting externally two are larger and more opaque (brownish), have short segments throughout their lower half, longer segments in their distal half, which is curved. The third bristle is considerably shorter, more translucent, and has long segments throughout its free portion, short segments occurring at its base—inserted in the tissues. The latter apparently represents a developing bristle. The dorsal bristles project upward and inward in a series of short fans, continue to the posterior end of the body and are of a resplendent pale hue, and the tips have a tendency to curve forward. The ventral bristles from the third backward present a gradual modification into stout hooks with bifid tips. Thus at the tenth these processes retain a bristle-like appearance, with long joints which, however, become shorter toward the tip, the latter tapering to a long terminal joint with a hook and a secondary process differentiated at its free edge, viz. a thickened rim, but the whole is bound to the concavity of the hook. At the twentieth foot a similar condition exists both as regards the bristle-like stem of the appendage, the shortening of the joints toward the tip, and the longer terminal joint with the hook, as well as the fixed secondary process beneath with the marginal differentiation, the whole having the aspect of a Polyzoan avicularian. The hook gradually becomes shorter, broader and stouter, the articulations more closely arranged, and between the fortieth and fiftieth feet (Plate CIV, fig. 6 *d*) the secondary process has in some lost its web, so that the thickened edge forms as it were the mandible below the hooked beak. Toward the tip of the tail the secondary process of the now short hook often disappears, and the terminal hook is considerably abraded. The hook is still flattened, and has oblique striæ below the translucent tip. The articulations are also very closely arranged.

It is interesting that a similar form should have been procured at sites so widely separated by the Atlantic, yet there is some doubt as regards specific identity both on account of the fewness of the branchiæ and other features in the British form.

4. Stylarioides flabellata, *Sars*, 1868. Plate XCVI, fig. 4; Plate CIV, figs. 3—3 *e*—bristles and hooks; Plate XCIV, fig. 1—tail.

Specific Characters.—Body about an inch in length, densely coated with sand-grains, Foraminifera and minute shell-fragments, and often of a ferruginous or blackish hue posteriorly, rounded, enlarged in the anterior third, and gently tapering to the posterior end which forms a short cone with the anus in the centre. Anterior end very little tapered, for it consists of a somewhat trifid region, with a prominent, conical oral process in the centre, and on each side the forwardly projecting first foot, with the long, finely iridescent bristles which in good examples are about a third the length of the body. Segmentation just observable anteriorly, but distinct posteriorly. Segments about thirty. The frontal cone has long papillæ with globular or clavate tips, and they give a characteristic fringe to the region. Two grooved and crenate palpi and a series of slender translucent branchiæ issue from the oral cone. Short segments characterise the base of the long first and second bristles, but the free portion in each has for the most part long joints. The tips are curved inward. Dorsal bristles of the third foot leave the body at a different angle, are much shorter, and the ventral take the form of long, flattened, jointed shafts which slightly increase distally where they are dilated and bent forward, whilst the tip consists of a flattened diminishing process with a well-marked hook. These hooks characterise a considerable region anteriorly, and gradually pass into simple hooks posteriorly. The dorsal bristles continue short and of the same structure throughout.

Synonyms.

1868. *Trophonia flabellata,* Sars. Christ. Vidensk.-Selsk. Forhandl., p. 10 (sep. copy).
1873. „ „ idem. Bidrag Christ. Fauna, p. 49, tab. xvii, figs. 1—12.
1877. *Stylarioides flabellata,* Grube. Abh. Schles. Gesellsch., Natur. Sect. (1876), p. 47.
1879. *Trophonia flabellata,* Tauber. Annul. Danica, p. 112.
1883. „ „ Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 122.
1894. „ „ Bidenkap. Christ. Vidensk.-Selsk. Forhandl., p. 105.
1897. *Stylarioides flabellatus,* Michaelsen. Polych. deutsch. Meere, p. 156.
1908. „ *flabellata,* McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 535, 541.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870 at Station No. VI (Channel Slope) 48° 26′ N., 9° 44′ W., in 358 fathoms; surface temperature 62°, bottom temperature 50·3° F.

A form frequenting deep water.

Abroad it has been found at 300 fathoms off Norway (M. Sars), Bergen and other parts of Norway, Hardanger Fjord, Dröbak, Christiania (Canon Norman).

A species about the size of *S. glauca*, but very readily distinguished therefrom by its dense coating of sand-grains, by the ferruginous hue of the posterior region, by the stronger frontal bristles, and by the conical anterior process with its long papillæ. The body is rounded, about an inch in length in the preparations and having about thirty bristled segments, slightly enlarged in the anterior third and gently tapering therefrom

to the posterior end which forms a short cone with the anus in the centre. The anterior region is very slightly tapered, for it ends in a somewhat trifid region with a prominent conical process for the attachment of the oral organs in the centre, and on each side is the slightly projecting first foot bearing the long finely iridescent bristles which in fine examples are one-third the length of the body. Except for the bristles the segmentation of the body would be obscured anteriorly, but the caudal region shows the segments more distinctly. The anterior region has the colour of the pale adherent sand-grains, but a ferruginous tint characterises the posterior end, occasionally more than a third of the total length of the annelid, both the sand-grains and secretion being affected. In regions so distant as Norway and the Channel Slope the same appearances characterised the species. In certain Norwegian examples collected by Canon Norman the ferruginous hue is replaced by black or brownish-black pigment, and occasionally both are present on the same form. Moreover, the sand-grains vary in size, and in the admixture of Foraminifera —probably according to the nature of the surroundings. Rarely the scarcity of sand-grains permits the segments of the body to be more easily recognised. In one or two the body is uniformly tinted by the greyish sand-grains. Besides the sand-grains, Foraminifera, and shell-fragments, the usual papillæ occur on the feet and on the general surface. These papillæ are considerably shorter than those on the frontal cone, but have the same globular tips. The longest papillæ occur on the first foot. From the frontal cone issue the two grooved and crenate palpi and above them a series of slender translucent branchiæ, but their number could not be accurately determined.

Anteriorly the dorsal median process (Plate XCVI, fig. 4) bears long papillæ, with globular or clavate tips, which give it a characteristic fringe under a lens, and on each side is the long, pale dorsal bristle-tuft, which passes forward and very slightly outward and upward, the tips having a ventral curvature. They are finely iridescent, gleaming with a greenish-blue sheen like the long bristles of *Mitraria*. When mounted in Farrant's solution they are brownish by transmitted light, have short articulations at the base, but the greater part of the free portion in each has long joints (Plate CIV, figs. 3 and 3 *a*). They taper to a fine point, show a distinct curvature, are somewhat stiff, and they form an even row or palisade in the tissues, with reserve-bristles developing at the base, and make a regular vertical fan-like series internally. The ventral bristles are only a little shorter, the regularly-arranged fan having a direction slightly outward and forward, while the lower bristles have a ventral tendency, and the tips curve inward. The angle these bristles form with the body is, of course, variable according to the condition of the muscles of the base on immersion in spirit. The bristles of the second foot—which is fused with the first in forming the lateral projection on each side anteriorly—are much shorter and more slender than the first, indeed, the dorsal do not appear to be more than half the length and the ventral are shorter. Their direction is also forward and slightly outward as in the first pair, and their structure both dorsally and ventrally seems to be the same, viz. long, tapering, jointed bristles. The bristles of the third foot leave the body at a different angle, projecting more directly outward and slightly forward. The dorsal series has the same structure, but the ventral differ, for they are long, jointed, flattened, nearly of equal diameter throughout, though really slightly increasing from the base to the end of the shaft, which is a little dilated and curved forward (Plate CIV,

figs. 3 *b*). The tip consists of a gradually diminished flattened process ending a well-marked hook, the whole structure being more conspicuous than the slender, tapering dorsal bristles. The dorsal bristles continue to the posterior end, and though short they are usually better seen on the last third than in the region in front (middle third), since these appear to be brittle and easily abraded. The long hooks just described occur throughout a considerable region anteriorly, but they gradually pass into simple hooks (Plate CIV, figs. 3 *c*—3 *e*) posteriorly, the tip being distinctly curved and the shaft crossed by incomplete transverse articulations in its free part. The bristles in this species are remarkably free from parasitic growths.

Posteriorly the body tapers gently to a bluntly-conical end (Plate XCIV, fig. 1).

Reproduction.—Specimens captured by Canon Norman in Norway in the summer, probably in July, 1879, have numerous ova in the body-cavity anteriorly, each with a pointed process, as if it had been developed on a stalk. In some the ova were large, rounded, and free in the cœlomic space, in which a few gregarines were also present.

5. Stylarioides Sarsi,[1] *McIntosh*, 1908. Plate XCVI, fig. 5; Plate CIV, figs. 5—5 *b*—bristles and hook.

Specific Characters.—Somewhat like *S. plumosa*, but with a shorter anterior region, fewer segments, more velvety surface, stiffer dorsal bristles; ventral of the third series forming long, stiff, straight bristles; hooks of the fourth pair are short, broad, flattened knives with a curve at the tip. This form of hook continues a short distance, and passes into a series of longer, rigid, lever-like spines posteriorly.

Synonym.

1908. *Stylarioides Sarsi*, McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, p. 536.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870, off Cape Sagres, in 45 fathoms, July 28th, amidst what was called a southern fauna.

A form (Plate XCVI, fig. 5) of fair size, and somewhat resembling *S. plumosa* in general aspect, yet it is essentially different. So far as the two fragments, apparently of the same animal, reveal, the shape is generally that of the common species, the entire surface being closely villous from clavate papillæ, which are longest on the first three segments, and especially the first, but no sand-grains are visible. The general colour is a khaki-brown, and the segments are more than twenty in number, probably thirty. The papillæ are smaller on the ventral surface, but, as on the dorsum, they are most conspicuous on the anterior segments. The anterior aperture for the emission of the oral organs is triangular, and resembles in position that of *S. plumosa*.

The first foot has very long, pale golden, iridescent bristles, which in the preparation pass forward and inward, so that they cross each other toward the tip, which shows only a trace of a curve. They and the next two groups are studded, both on the foot at the base as well as on the bristles, with Loxosomæ, which have buds at various stages projecting from the parents. In structure the dorsal bristles (Plate CIV, figs. 5 and 5 *a*)

[1] Named in honour of Prof. Michael Sars, the distinguished investigator of the Fauna of the northern seas.

have narrow segments at the base and for a long distance outward, then toward the tip the segments increase in length, but irregularly, two, three, or four short segments being followed by a longer, and so on, to the delicately tapered tip. In some instances the smaller segments are incomplete—the lines running only partially inward. The ventral of the first set are a little shorter, but show the same structure. The second series is considerably shorter, but conforms to the same type. These bristles likewise pass forward and have only a trace of a curvature toward the tip, viz. ventrally in the dorsal and dorsally in the ventral. The dorsal bristles of the third series are shorter and more slender, but also go forward as a fan, and their tips are slightly curved ventrally. The ventral have increased in strength and form a stiff fan of comparatively long bristles, which spread upward and inward dorsally, so that much of the fan is seen from the dorsal surface. They taper from base to apex, and the segments increase gradually in length toward the tip, which generally is abraded. These would appear to be of considerable service to the annelid in its tunnel in the mud. Long papillæ occur on the dorsal division of this and the adjoining feet. The fourth foot has slender dorsal bristles passing forward, and ventrally a row of stiff, flattened hooks (Plate CIV, fig. 5 *b*) with closely articulated shafts and broad, flattened, translucent hedge-bill-like tips, with a well-marked hook. Oblique striæ occur as the transverse lines (at the articulations) wane. Besides these is a form (Plate CIV, fig. 5 *c*), simply curved like a tapering spatula and having articulations nearly to the tip. The dorsal bristles form somewhat stiff fans directed slightly forward and upward and extending to the posterior end of the fragment. The ventral hooks again remain of the broad knife-shape (Plate CIV, fig. 5 *d*) only for a short distance, gradually becoming more elongated (Plate CIV, fig. 5 *e*) posteriorly, a typical foot there showing about five rigid hooks with a slight curvature of the shaft, and ending in a point (generally abraded) with only a trace of a bend near the tip. These would thus act as lever-like spines, whilst the anterior are more adapted for clinging.

This species has certain resemblances to *S. plumosa*, but is distinguished by the form of the body, the shorter anterior region, fewer segments, and the nature of the bristles and hooks.

Genus XCII.—Brada, *Stimpson*.

Generic Characters.—The distinctions between *Brada* and *Stylarioides* do not rest on the absence of the frontal bristles, as De Quatrefages states, for the first and second pairs of dorsal bristles, though short, are fairly conspicuous. Moreover, one section of the genus, viz. that represented by *Brada villosa*, H. Rathke, leans closely to *Stylarioides*, especially that group with more or less straight ventral bristles, yet they are distinguished by the genital papillæ between the fourth and fifth bristled segments in *Brada*—even in the elongated type with forty-five segments. The setigerous process for the ventral bristles is more distinct in *Brada*, and may show a circlet of papillæ at its base. The palpi and numerous filiform branchiæ in two groups characterise *Brada*, as well as *Stylarioides*. In *Brada* the ovaries form dense clusters in the sixth, seventh, and eighth bristled segments, that is, behind the genital papillæ. Some species of *Brada*, *e.g.* *B. mamillata*, have a wide distribution, for Grube describes this from Kerguelen.

De Quatrefages (1865), while distinguishing the genus *Brada* by having the head devoid of the double tuft of bristles, included such forms as *B. villosa* under his genus *Pherusa*.

1. Brada villosa, *H. Rathke, var.* Plate XCV, fig. 12; Plate XCVI, figs. 6—6 *c* and fig. 12 —body, papillæ, etc.; Plate CII, figs. 2 and 2 *a*.

Specific Characters.—Body, about 2 in. in length, of a uniform sand-colour, slightly fusiform in outline, but tapered more distinctly posteriorly. Surface studded with long clavate papillæ, especially in the frontal region and on the feet, and closely beset with sand-grains, so that the aspect of the dorsum is remarkably rough. Bristled segments about forty-five, the body terminating posteriorly in a blunt cone, with the anus in the centre. On the ventral surface, between the fourth and fifth bristled segments, is the genital papilla on each side just within the base of the foot. The large aperture for the issue of the oral organs lies just behind the tip ventrally, and when open shows a broad everted lip. Frontal bristles (of the first and second pairs) remarkably delicate, short, tapering to a fine point, pale, and with long joints. The ventral of the second pair resemble the succeeding, viz. stiff, closely articulated bristles, with a finely tapered translucent tip. The rest have a similar structure, and are perhaps most conspicuous on the narrow region in front of the tail, which has three diminishing rings behind the last with bristles.

A species distinguished by its hirsute, sandy aspect, and the shortness and delicacy of its bristles.

Synonyms.

1843. *Siphonostoma villosum,* H. Rathke. Nova Acta Acad. Leop.-Car., t. xx, p. 215, Tab. xi, figs. 11 and 12.
1858. *Siphonostomum villosum,* Grube. Mém. sav. étrang. St. Pétersb., t. viii, p. 16 (sep. copy).
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift. IV, p. 120.
1861. „ „ idem. Reise, 1857, Nyt Mag. f. Naturvid., p. 54.
1865. *Pherusa villosa,* De Quatrefages. Annel., i, p. 483.
1867. *Brada villosa,* Malmgren. Annul. Polych., p. 84.
1869. „ „ Sars. Christianiafj., iii, p. 81.
1873. „ „ idem. Bidrag. Christ. Fauna, p. 61.
„ „ „ idem. Nyt Mag. f. Naturvid., xix, p. 261.
1877. „ „ Grube. Abh. Schles. Gesellsch. Nat. (1876), p. 46.
„ „ „ Marenzeller. Denkschr. K. Akad. Wissensch., Wien., Bd. xxxv, p. 35.
1879. „ „ Tauber. Annul. Danica, p. 113.
„ „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 53.
1882. *Trophonia arctica,* Hansen. Norw. N. Atlant. Exped. Annel., p. 39, pl. vii, figs. 17—20.
1883. *Brada villosa,* Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 123.
„ „ „ Wirén. Chætop. 'Vega' Exped., p. 408.
1889. „ „ Marenzeller. Arch. f. Naturges, lv, p. 132.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 105.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 158.

1898. *Brada villosa,* Michaelsen. Grönländ Annel., p. 129.
1907. „ „ Fauvel. Bull. Inst. Ocean., No. 107, p. 22.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 538, 540, and 541.
„ „ „ Moore. Proc. Acad. Nat. Sc. Philad., vol. xl, p. 357.
1909. „ „ Fauvel. Bull. Inst. Ocean., No. 142, p. 6.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870 at Station 8 on the Channel Slope in 257 fathoms amidst a northern fauna. Also dredged in the 'Knight Errant' August 17th, 1880, at a depth of 540 fathoms at Station 8.

Abroad it extends to Spitzbergen, Norway, Sweden, and Finmark, and northern seas generally (Malmgren, Norman, Fauvel); Greenland (Michaelsen).

Arctic Sea (Marenzeller) and Pacific coast of North America (Moore).

The *anterior end* (Plate XCV, fig. 12, and Plate XCVI, fig. 6) is bluntly rounded, and the feeble development of the frontal bristles, for instance, in contrast with those of *S. plumosa*, indicates a difference in surroundings, the present form probably inhabiting soft mud in deep water. The anterior aperture has a broad arch superiorly, the margin being papillose, whilst the posterior lip is deeply sinuous ventrally, the whole forming a large opening with a broad pouting rim ventrally. In this aperture lie the two broad crenate and grooved palpi, and above them the slender branchiæ.

Body fusiform, tapered anteriorly, and more distinctly posteriorly, where it ends in a bluntly-conical tail with the anus in the centre. Three diminishing smooth rings occur behind the last bearing bristles. The dorsum is rough, with long papillæ (Plate XCVI, fig. 6 *b*) and sand-grains; the ventral surface is less rough anteriorly in the enlarged region, the sand-grains being smaller, and the same may be said of the posterior half. Both offer a contrast to the rougher dorsal surface. The bristled segments are in the large example forty-six in number. The frontal bristles of the first pair are very slender and inconspicuous (Plate XCV, fig. 12, and Plate XCVI, fig. 6), and do not extend forward the breadth of the body. They are pale, tapering bristles, with long points and very fine hair-like tips. The bristles of this region, therefore, are in contrast with the long, clavate papillæ which fringe the same margin. The dorsal bristles of the second series are still shorter and equally slender, but they are directed forward and slightly outward. The ventral on the other hand have assumed the characteristic stout shafts and finely-tapered tips of those on the rest of the body, and the bristles spring from a smooth, conical setigerous process with long clavate papillæ at its base. The remarkable prominence of the ventral division of the foot throughout the entire length is noteworthy. The third series presents short dorsal bristles of the same character, and the prominent ventral process has a stiff set with curved and tapered points. The ventral series throughout consists of rather long, stout, closely articulated bristles with very finely tapered and curved tips (Plate CII, fig. 2 *a*), devoid of articulations. Both bristles and hooks are proportionally better developed in the narrower posterior region in front of the tail.

Embedded between the fourth and fifth segments on the ventral surface is a cylindrical or slightly-flattened structure (genital papilla) with a smoothly rounded free end, the other being inserted into the muscular walls of the body (Plate XCVI, fig. 12). Whilst the distal part of the structure is smooth, the lower half appears to have a coating

of sand-grains like the rest of the body. It varies in length in the females, some having long, others short papillæ.

The ovaries are attached by slender pedicles to the ventral wall of the body on the sixth, seventh, and eighth bristled segments, but a long pedicle enables a mass to lie in the ninth.

A curious crustacean parasite (*Bradophila pygmæa*) was found in the anterior part of the alimentary canal of *Brada villosa* by Levinsen.[1]

This form appears to agree closely with the *Trophonia arctica* of Hansen (1882) from Magdalena Bay, in 20 fathoms. He, however, describes the dorsal surface as uniformly granulated, and the papillæ on the ventral surface fewer and smaller. On the whole, Hansen's form is smoother.

It has certain resemblances to the *Siphonostomum villosum* of H. Rathke, though his examples were small and short, probably incomplete. The special characters of the ventral division of the foot and the somewhat stellate arrangement of the papillæ around each (when viewed on end), generally correspond. Unfortunately, he did not enter minutely into the structure of the bristles or figure them.

There are apparently two varieties of *Brada villosa*, viz. the shorter northern form and the more elongated form from the 'Knight Errant' (Plate XCVI, fig. 6). Both have the dense coating of sand-grains which, with the papillæ, make the dorsum remarkably rugose, yet there are considerable differences in the shorter northern forms from Finmark, some of which are much less covered with sand. Both have the genital papillæ exactly in the same position and of like shape, yet amongst those from Greenland and from Finmark the length of these papillæ varies, some having them short, others long, so that sexual distinctions in this respect may exist. The number of segments in the shorter northern form is about twenty-three, whereas the specimen from the 'Knight Errant' has forty-five. The bristles of the two series agree in structure, though it must be stated that the long example from the 'Knight Errant' has dorsal and ventral bristles of a more slender character than the northern, and they are paler. The papillæ in the example from the 'Knight Errant' are longer and more slender, both dorsally and ventrally. The shorter variety, with about twenty-two bristled segments, would appear to correspond with Rathke's *Siphonostomum villosum*.

Parasites.—Projecting from the anterior opening of the example from the 'Knight Errant' are a series of minute whitish bodies, which appeared to be Infusorial parasites attached to a branched axis like *Carchesium*.

Genus XCIII.—Flabelligera, *Sars*, 1829.

Siphonostoma, Otto[2]; *Syphostoma*, Cuvier; *Chlorhæma*, Dujardin; *Lophiocephala*, Costa; *Siphonostomum*, Grube.

[1] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1887, p. 23, figs. c to e.

[2] 'Animalium maritimorum nondum editorum genera dua De Sternaspido et Siphonostomida,' Vratislaviæ, 1820.

The genus was first characterised by Otto (1820) under the name of *Siphostoma*, but this term had formerly been employed by Raphinesque in 1810 for a genus of Lophobranchs. After Sars had given the above title Dujardin in 1838 applied the term *Chloræma* to replace Otto's name. Claparède holds that Otto's name, *Siphostoma*, corrected to *Siphonostoma* should stand.

Body enveloped in mucus; long cuticular papillæ; setæ of the anterior region turned forward so as to form a cephalic funnel, with a large number of branchial filaments on each side of the head.

Delle Chiaje,[1] in 1841, described *Siphonostoma* as having a free body, attenuated posteriorly, covered with mucous follicles, having long opposing bristles in front, protecting the branchial cirri, a group of tentacles in front, and a uniramous foot.

1. Flabelligera affinis, *Sars*, 1851. Plate LXXXIX, fig. 2; Plate XCVI, fig. 10—papillæ; Plate CIV, figs. 7—7*b*—bristles.

Specific Characters.—Body about 3 inches in length, tapered a little anteriorly to the base of the bristle-fan, and much more posteriorly, somewhat flattened, especially ventrally. Segments, thirty to forty-five. Enveloped in a transparent gelatinous investment to the tips of the bristles, and with a dense series of long papillæ with urn-like and clavate tips. Colour brownish-green anteriorly, or greenish with a central streak of reddish-brown, then pale green in the middle line posteriorly with the same margin as in front. Groups of white grains occur in every segment throughout the greater part of the body. Branchiæ, twenty to twenty-five, green; palpi pale yellow or orange. Mouth with a dark brown pigment-ring. Tongue-shaped process passes from the mouth dorsally between the bristle-fans. Dorsal and ventral bristles of the first set form a vertical fan on each side. They are directed forward, as also are the dorsals of the second and third. All are articulated. The ventral setigerous process of the second set carries a single long hook with a ringed shaft, which dilates a little at the articulation; the terminal claw, which is borne at a large angle to the shaft, has a slight median dilatation (variable), and ends in a sharply-curved brown tip.

Synonyms.

1829. *Flabelligera affinis*, Sars. Bidrag til Söedyr. Nat., i, p. 31, Tab. 3, f. 16.
1835. „ „ idem. Beskriv. og Iagtt., p. 47.
1839. *Chloræma Edwardsii*, Dujardin. Ann. Sc. nat., 2e sér., t. xi, p. 288, pl. vii, figs. 1—5.
1840. *Siphonostomum papillosum*, Grube. Actin. Echin. u. Würm., p. 68.
1841. ? *Siphonostoma diplochiatos*, Delle Chiaje. Descriz., vol. iii, p. 77, Tav. 99, f. 8.
1843. *Siphonostomum vaginiferum*, H. Rathke. Nova Acta Acad. Leop.-Car., xx, p. 211, Tab. xi, f. 3—10.
„ *Siphonostoma uncinata*, M. Edwards. Cuvier's Règne Anim., Disciples Edit., Annel., p. 27, Tab. 6, f. 4—4 *a*.
1844. *Chloræma Edwardsii*, Œrsted. Reg. Mar., p. 79.
1849. *Siphonostoma vaginiferum*, Leuckart. Arch. f. Naturges, Bd. xv, p. 164.
„ *Chloræma Dujardini*, De Quatrefages. Ann. Sc. nat., 3e sér., t. xii, p. 282, pl. ix, figs. 1—9 (young).

[1] 'Descriz.,' vol. iii, p. 74.

1849. *Chloræma sordidum.* De Quatrefages. Ann. Sc. nat., 3e sér., t. xii, p. 285, pl. ix, fig. 10.
1851. *Siphonostomum vaginiferum,* Sars. Nyt Mag. f. Naturvid.,, Bd. vi, pp. 132, 206, 281.
„ „ *Edwardsii,* Grube. Fam. Annel., pp. 72 and 136.
1853. „ *vaginiferum,* Sars. Nyt Mag. f. Naturvid., Bd. vii, pp. 386 and 390.
„ *Siphonostoma gelatinosa,* Dalyell. Pow. Creat., vol. ii, p. 256, pl. xviii, figs. 10—12.
„ *Tecturella flaccida,* Stimpson. Mar. Invert. Grand Manan, p. 32, Tab. iii, f. 21.
1855. *Siphonostomum affine,* Leidy. Invert. Rhode Isl., etc., p. 148.
1857. „ *vaginiferum,* Koren. Nyt Mag. f. Naturvid., ix, p. 94.
1859. „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 120.
1861. „ „ idem. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 54.
1864. „ *diplochaitos,* Kölliker. Kurzer Bericht, pp. 10 and 17, pl. vi, fig. 7.
1865. *Pherusa vaginifera,* De Quatrefages. Annel., i, p. 483.
„ *Chloræma Dujardini,* idem. Ibid., p. 472, pl. i, fig. 2; pl. ii, figs. 7—13; and pl. xii, fig. 2.
„ „ *sordidum,* idem. Ibid., i, p. 474, pl. xii, figs. 3—6.
„ *Siphonostoma uncinata,* Johnston. Cat. Worms Brit. Mus., pp. 223 and 344.
1867. *Flabelligera affinis,* Malmgren. Annul. Polych., p. 83.
1873. *Siphonostomum vaginiferum,* Sars. Nyt Mag. f. Naturvid., xix, p. 247.
„ *Chloræmum pellucidum,* idem. Ibid., p. 252.
1874. *Flabelligera affinis,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 126.
„ ? *Siphonostoma diplochaitos,* Pauceri. Atti Soc. Ital., vol. xviii, p. 529.
1877. *Flabelligera affinis,* Grube. Jahres. Schles. Gesells., p. 7.
1878. „ „ McIntosh. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 506.
1879. „ „ Tauber. Annul. Danica, p. 113.
1883. „ „ Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 122.
„ *Siphonostomum vaginiferum,* Wirén. Chætop. 'Vega' Exped., p. 407.
1886. *Flabelligera affinis,* Levinsen. Kara-Havets, etc., p. 9.
„ *Siphonostomum gelatinosum,* Harvey Gibson. Proc. Lit. and Philos. Soc. Liverp., vol. xl, p. 158.
1887 ?. *Siphonostoma diplochætos,* Jourdan. Ann. Mus. Marseille Zool., t. iii, pls. 1—4.
1888. *Flabelligera affinis,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 677, pl. xlvi, fig. 40.
1889. „ „ Marenzeller. Arch. f. Naturges., lv, p. 132.
1890. *Siphonostoma* (*Chloræma*) *Dujardini,* Malaquin. Annél. Boulon., p. 18.
1891. „ *diplochaitos,* Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 256.
1894. *Flabelligera affinis,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 96.
„ „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 103.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 156.
1898. „ „ idem. Grönländ. Annel., p. 129.
1900. *Siphonostoma affinis,* Newbigin. Ann. Nat. Hist., ser. 7, vol. v, p. 190, pl. iv, figs. 5 and 6.
1904. „ (*Flabelligera*) *affinis,* Journ. M. B. A., vol. vii, p. 231.
1907. *Flabelligera affinis,* Fauvel. Bull. Inst. Ocean., No. 107, p. 19.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, pp. 532 and 541.
1909. „ „ Percy Moore. Proc. U.S. Nat. Mus., vol. xxxvii, p. 143.
1910. „ „ Southern. Proc. R. Irish Acad., vol. xxviii, p. 241.
1912. „ „ Ditlevsen. Danmark Exsped. Grönl., Bd. v, p. 426.[1]
1913. *Siphonostoma Dujardini* and *affinis,* Giard. Œuvres Divers, p. 56.
„ *Flabelligera affinis,* Augener. Zool. Anzeiger, Bd. xli, p. 267.
1914. „ „ Southern. Proc. R. Irish Acad., vol. xxxi, pt. 47, p. 138.

[1] *Vide* also Kurt Günther, 'Jen. Zeitschr. Naturw.,' xlviii, pp. 98—186, 1 pl. and 55 figs., 1912.

Habitat.—Occasionally between tide-marks under stones in rock-pools at St. Andrews, and common in the interstices of *Filograna implexa* near the Bell Rock. Stomach of haddock, St. Andrews (E. McIntosh); in the crevices of the nests of *Lima hians*, Firth of Clyde (Dr. Grieve and Miss Newbigin); between tide-marks under stones in rock-pools and between the valves of dead Lamellibranchs where few corallines or other structures are present; and dredged on the oyster banks and in 15 fathoms off St. Peter Port, Guernsey, and similarly at Herm (W. C. M.); Bressay Sound, 8—10 fathoms, amongst tangle-roots (W. C. M.); Lamlash, Arran (Dr. Howden); not infrequent between tide-marks at Lochmaddy, North Uist, clinging to *Halichondria panicea* under stones, and again in 4—9 fathoms in the loch (W. C. M.). Plymouth (Allen); Dalkey Sound and Dublin Bay (A. C. Haddon); Malahide, Blacksod, Clew and other bays on the west of Ireland (Southern); Forth (Cunningham and Ramage). 'Porcupine' Expedition of 1869. Appears to be generally distributed around the shores of Great Britain and Ireland, fine examples being present in most of the localities named, the northern, perhaps, exceeding those from the Channel Islands in size.

Elsewhere it extends to Spitzbergen, Greenland, Iceland, Scandinavia, Finmark and the shores of France, as well as to the Atlantic coast, U.S.A. (Verrill); Mediterranean (Dujardin); Behring Sea and North Sea (Wirén); Franz-Joseph Land (Augener); N.E. America (Moore).

The *body* is enveloped by the translucent secretion of the skin-glands which permits only the tips of the bristles to protrude, and the same substance makes the frontal fans of bristles into complete webs, with the long slender stalks of the papillæ bearing the clavate or urn-shaped (lageniform) heads mingled with it. The tips of many of the urn-shaped papillæ indeed almost extend forward as far as the ends of the bristles (Plate XCVI, fig. 10). The gelatinous secretion has in it many cells and granules, mud, minute sand-grains, young annelids such as *Arenicola*, and other *débris*. When the extraneous matter is removed a milky membrane remains along the sides of the body ensheathing the dorsal bristles, and consisting of a more translucent secretion crowded with the clavate papillæ and their long stalks, besides here and there a minute Nematode. During life, indeed, many small marine forms are entangled in the gelatinous investment.

It is interesting that the urn-shaped papillæ (the pedicled glands of Dujardin) undergo considerable changes during the growth of the animal, for the young examples have the tips longer and more slender, very little enlargement occurring at the base of the urn.

These papillæ were considered to be glandular by Dujardin and Max Müller, and that they secreted mucus; tactile by Kölliker,[1] Claparède,[2] Joyeux-Laffuie[3] and Haswell[4]; whereas Delle Chiaje thought they were pedicled parasites, viz. "*animacules botryoides*"; Leuckart that they were penetrated by vascular twigs. Costa called them con-

[1] 'Kürzer Bericht,' etc., 'Würzb. Naturw. Zeitschr.,' Bd. v, 1864, p. 248, pl. vi, fig. 7.

[2] 'Annél. Nap.,' p. 371, pl. xxv, figs. 3*c* and 3*d*.

[3] 'Compt. Rend. Acad. Sc.,' t. civ, p. 1378, 1887.

[4] 'Trans. Linn. Soc. N. S. Wales,' vol. vi, 1891, p. 340. See also Jourdan, 'Ann. du Musée d'Hist. Nat. Marseille,' t. iii, p. 21, pl. i, figs. 11 and 12.

globate glands and De Quatrefages hairs. De St. Joseph again was of opinion they might perform both functions (sensory and glandular). The living animal is certainly endowed with great sensibility, and apparently these organs are largely connected therewith.

This form likewise has a heart-body, Cunningham[1] figuring it in sections as a fimbriated cellular process.

The *body*, which is about three inches long, and has from thirty to forty-five bristled segments, is somewhat fusiform, tapered a little anteriorly to the base of the fan of bristles, and much more gradually posteriorly where it ends in a vent at the conical tip, the bristles and papillæ in the most perfect examples projecting slightly beyond it. In life it appears to be enveloped in a transparent and slightly milky gelatinous investment which just allows the tips of the bristles to protrude beyond it, and this is studded with minute oval specks—the papillæ. The colour is brownish-green anteriorly with a central streak of reddish-brown in some, darker brown in others, the margin being greenish or bluish, then pale green in the central line with a similar margin on each side posteriorly. On every segment for three-fourths of the length are several groups of white grains. Some have a fine translucent bluish shade—due to the bluish specks in the gelatinous investment. The branchiæ are green, and the palpi yellowish or orange (yellow or roseate, De St. Joseph) and when the annelid is immersed in spirit it gives the fluid a rich brownish tint.

In life, when the anterior fan or collar is expanded, a series of ciliated green branchiæ appear dorsally in two groups (twenty to twenty-five in each) and the two crenated palpi with their ventral groove, both fixed to the central process, which has the dark mouth in the centre. A broad collar from the dorsal margin of the process gives origin to the branchiæ, that is, they spring from its edge, whilst in the middle line the tongue-shaped process passes dorsally between the dense lateral groups of branchiæ, the other or broad end joining the fillet around the mouth in the centre ventrally. This tongue-shaped process has a narrow lateral band which runs from the base to the tip on each side, and a median band in *S. diplochaitos*, which, as De St. Joseph states, shows differences, probably the "two lèvres ventrales rétractiles" of this author. Two ovoid elevations occur below the mouth, one on each side, and then, ventrally and externally, are the palpi with their deep ventral grooves. The whole apparatus recalls the complex oral region of *Phoronis*, and probably similar functions are performed by the various parts, especially by the palpi.

The mouth itself is surrounded by a dark brown pigment-ring, apparently a rudimentary dental apparatus, the brown deposit being arranged in semicircles and isolated patches.

Anteriorly the dorsal and ventral bristles of the first foot are modified to form on each side a beautiful vertical fan of pale resplendent bristles which support a granular membrane like a web, the whole now and then assuming the form of a horse-shoe. They are so arranged that the longer bristles in each are lateral, the groups ending in a gradually diminishing series dorsally and ventrally, yet the longest are beneath the middle of the series. A long, acutely triangular gap on each side as far forward as the

[1] 'Quart. Journ. Micr. Sci.,' vol. xxviii, N.S., pl. xix, fig. 20, 1888.

edge of the collar marks the separation between the dorsal and ventral divisions. These frontal bristles (Plate CIV, fig. 7) are pale brownish by transmitted light, long, slender, tapering, with moderate joints which become longer toward the tip and which De St. Joseph likens to Confervæ. They vary considerably in strength, the most robust being those in an example from the 'Valorous' in 1875. Much of the shaft inserted in the tissues is devoid of segmentation.

The second set of bristles inaugurates those characteristic of the rest of the body, but the dorsal of this and the next series or two have a tendency to a forward direction, as also have the ventral hooks. These bristles are, on the whole, stronger than the frontal, and the lines of segmentation are much closer. They are enveloped in the milky membrane and its long-stalked papillæ with the urn-shaped tips almost to their extremities, and there are also many of the clavate papillæ. These bristles in ordinary preparations thus extend from the sides, generally nearly straight outward, or with a slight obliquity backward, enveloped in the gelatinous coating, and with the tips of the long papillæ projecting around. Minute particles of mud and sand-grains are thickly dotted on the pyramid thus formed. The enormous number of these organs indicates their importance in the economy of the species. Ventrally a single long, flattened hook (Plate CIV, fig. 7 *a*) projects forward and outward from a conical papilla, the shaft being deeply inserted in the tissues along with a reserve-hook and a group of finely tapered bristles, mostly without any distinct trace of transverse articulations, though a few show very faint transverse lines in the distal third. These bristles appear to vary in number —from six to twelve. As De St. Joseph[1] describes and figures them distinctly articulated considerable variation must occur. The British examples thus differ, though the faint indications of transverse striæ are noteworthy in this respect. The shaft is closely-ringed at the base, then some increasingly wider segments (four to five) occur, followed by narrow segments to the bare space below the hook at the tip. The end of the shaft dilates a little at the articulation of the hook and has oblique striæ internally. From the articulation the hook extends upward and slightly inward (at a large angle to the shaft) to a median dilatation, which varies in specimens from different localities, and then tapers to the sharply-curved brown tip, which De St. Joseph likens to the horn of a chamois (Plate CIV, fig. 7 *a*). It is obliquely striated internally almost to the tip. Like the dorsal bristles it is surrounded by many of the long urn-shaped papillæ distally, and various clavate forms proximally—all with the thread-like pedicles. The row of these glittering golden hooks with their brown tips stretches along each side ventrally, a single hook, as a rule, projecting from each foot, though occasionally two occur. They are smaller toward the tail, but do not differ in structure, or in the presence of a single reserve-hook, and the group of simple tapering bristles supporting the shaft of the main hook in the tissues; nor do the papillæ undergo any change of note. For comparison a hook of *S. diplochaitos* from Naples is shown in Plate CIV, fig. 2. The hooks are coated with a fine transparent gelatinous secretion almost to the tip. In large examples from Greenland both the shaft and the tip of the hook are of a deep bro.. ., and opaque under the microscope, but their structure is similar. The same may be said of the dorsal fascicle of simple tapering, closely-ringed bristles and their papillæ. Looking generally

[1] Ann. Sc. nat., sér. 7, t. xvii, p. 98, pl. v, fig. 122.

at a series of spirit-preparations both bristles and hooks have a tendency to point downward with varying degrees of obliquity.

De St. Joseph describes two long white segmental organs in the seven or eight anterior segments, also two eyes (each of two coalesced) over the brain, and six pairs of genital glands anteriorly.

This is one of the most beautiful members of the group, for it is enveloped, as it were, in a fairy covering of gauze or lace, the pale bluish lustre of which enhances the effect of its fine colours and resplendent bristles and hooks. The bluish hue is stated by Claparède to be due to the granulations in the papillæ, the papillæ helping to keep the animal, surrounded as it is by its translucent investment, in touch with the outer world.

Habits.—When lodged in the crevices of *Filograna implexa* considerable difficulty is experienced in extricating it without rupture, since it clings tenaciously to its surroundings, and even avoids exposure of its body where its retreat can be intercepted. Occasionally it swayed the body to and fro in a glass vessel without moving from the spot, or in other cases, and as Dr. Grieve, of Glasgow, long ago noticed, it swam in a vessel of sea-water with considerable facility. Frequently the body is contracted from behind forward, and the frontal fans of bristles bend over the green branchiæ when danger appears imminent. Though not gifted with powers of rapid locomotion on the bottom, yet it frequently climbs on *Ceramium rubrum* and other sea-weeds, and having settled in a comfortable position, which it can so readily do by means of its fine hooks, the anterior end is thrust in various directions whilst the frontal fans are expanded and the yellow palpi search and feel constantly all around, indeed, the body is seldom at rest anteriorly.

Reproduction.—In July and August many of the examples, and a few of these were small, procured between tide-marks and dredged off shore in the Channel Islands, and those obtained in the latter month in Lochmaddy, had the body-cavity crowded with ova, which in the preparations retain a greyish-brown hue or just a trace of madder-brown. These are apparently nearly ripe and with a tough capsule, so that the breeding season is nigh. In some they fill the cœlom from the dorsal to the ventral surface, only a brief area at head and tail respectively being free, and they give a characteristic firmness and rigidity to the body. In others, and some of these were small, masses of what seemed to be nearly ripe sperms occurred as whitish masses which gave the body a distinctly segmented appearance, apart from the feet and their bristles. Coloration, therefore, at this season, readily distinguishes the sexes of the mature examples.

Dalyell[1] notes that a quantity of green spawn once appeared in a vessel containing a specimen in the beginning of June.

De St. Joseph (1894) observes that the ova are brownish or greenish-brown.

Krukenberg[2] again describes generally the greenish pigment in the ova of *Siphonostoma diplochaitos.*

Montagu[3] (1808) has a coloured figure of this species, but appends no name.

In 1820 A. G. Otto[4] gave a structural description of *Siphostoma diplochaitus* in which

[1] 'Pow. Creat.,' vol. ii, p. 257.

[2] 'Vergl.-Phys. Stud., 2 Reihe, 3te Abth.,' p. 6, Heidleberg, 1882.

[3] MS. vol. (1808) Linnean Soc., pl. lvii.

[4] 'De Sternaspide et Siphonostomate, Vratislaviæ,' 1820.

he found two oral apertures, and two gullets—since he considered the cardiac body as one of them. His figures are artistic though perhaps not quite accurate. His views were adversely criticised by Maximilian Müller[1] (1852), who pointed out that Otto had mistaken the anterior vascular trunk for a second œsophagus. He described and figured the cæcal appendage of the stomach as somewhat spiral. The segmental organs were his salivary glands.

When a theological candidate in 1829 the elder Sars[2] introduced this species to science in a careful description accompanied by recognisable figures.

Dujardin (1839) found this form on the shores of the Channel, and described and figured it under the name of *Chloræma Edwardsi*. His figures of the hooks, bristles, and papillæ are fair.

Leuckart (1849) gave details of its structure. He could not find the opening of the so-called accessory organ (heart-body), which Rathke thought to be a salivary gland. He considered it might be homologous with the Polian vesicles of Echinoderms.

Kölliker, in 1864, mentions that he procured *Siphonostomum diplochaitos* at Millport, but in all probability this was the common species. He gives an account of the papillæ with a figure.

The *Chloræma pellucidum* of Sars (1873) does not seem to differ materially from the present species.

A memoir on the structure of *Siphonostoma diplochætos*, Otto, by Jourdan[3] appeared in 1887. He gives an interesting description of the general anatomy, and especially of the minute structure of the four eyes over the brain, and the circulatory importance of the investment of the gastro-œsophageal cæcum, for so he called the heart-body, which he diagnosed as an appendage connected with the œsophageal canal, whilst its "couche peripherique" was muscular, contained blood, and pulsated rhythmically like a heart.

Cunningham and Ramage (1888) mention six pairs of gonads, the longer posterior ones being bound together with the loop of intestine into a cylindrical mass. The ovaries are green, and the testes white.

Dr. H. C. Sorby[4] (1906) found this species swimming in considerable numbers near the surface in the Orwell, and as those kept alive voided ova, he thought that they had assumed the pelagic state to disperse their ova.

This differs from *F. diplochaitos*, Delle Chiaje, from Naples, in the shape of the papillæ, which have much more elongated "heads" or ends than in the British form, and these, with the urn-shaped extremities, are also proportionally longer. Instead of a single hook as a rule occurring ventrally the Neapolitan form has two or three, and the hooks themselves offer certain differential features, such as the greater length and slenderness in the southern form (Plate CIV, fig. 2), their pallor, and the more uniform outline of the hook at the tip. All these features, however, may be the result of modification in different surroundings, just as it is found that the transverse segmentation of the hooks vary much in the British forms.

[1] 'Observ. Verm. quib. Marin.,' p. 7, Tab. ii, figs. 1–18.

[2] 'Bidrag. til söedyrenes Naturhist.,' Bergen, 1829, p. 31, Tab. iii, figs. 16–19.

[3] 'Annales Musée Hist. Nat. de Marseille,' vol. iii, pp. 1—43, 4 pls.

[4] 'Journ. Linn. Soc.,' vol. xxix, p. 437.

Miss Newbigin[1] (1900), in her account of the forms procured in the Clyde, concluded that *Siphonostoma diplochaitos*, *S. affinis*, and *S. Claparedii* may be varieties of the same species, a view put forward by Cunningham and Ramage[2] many years previously.

Kurt Günther[3] (1912) gives a detailed account of the histological structure of this form, which he thinks is probably "intermediate between the Terebellids and the Serpulidæ."

2. Flabelligera affinis, *var.*

A form dredged in the 'Porcupine' Expedition of 1869 in 110 fathoms on a sandy ground off Valencia, Ireland, varies a little in the great length of the urn-shaped papillæ and in the less clavate form of the other kind, the tips, indeed, being elongate-ovoid. The frontal bristles are translucent and slender (Plate XCVII, fig. 4), and their articulations are longer than in *F. affinis*. The claw at the tip of the hook (Plate XCVII, fig. 4 *a*) is longer and more distinctly curved, and the articulations of the shaft are wider. It is right to add, however, that considerable differences exist between the young forms and the adults of *F. affinis*, and this specimen is comparatively small.

Similar remarks apply to a fragmentary example from the 'Porcupine' Expedition of 1870, dredged in 257 fathoms in the Atlantic. The slenderness of the shafts of the hooks, their wide articulations, and the size of the terminal claw bring this variety near *Flabelligera Buskii*.

3. Flabelligera buskii, *McIntosh*, 1869. Plate XCVI, fig. 11—papilla; Plate CII, figs. 3—3 *b*—bristle and hook; Plate CIV, figs. 8—8 *b*—bristles.

Specific Characters.—Body about half an inch in length and having the outline of a young example of *F. affinis*, both as regards gelatinous investment and the urn-shaped and clavate papillæ, but the former have a coarser central axis, and the latter are smaller and have thicker stalks. Palpi pale; body and branchiæ bright red. Frontal bristles translucent and delicate, and the articulations wide. Hooks have slender shafts with longer articulations, and the terminal claw is wider toward the base, is longer, and has a smaller angle with the shaft; hooks often in pairs.

Synonyms.

1869. *Siphonostoma buskii*, McIntosh. Trans. Roy. Soc. Edinb., xxv, p. 420, pl. xv, fig. 13 *a*; and pl. xvi, figs. 4 and 4 *a*.

1908. *Flabelligera buskii*, McIntosh. Ann. Nat. Hist., 8 ser., vol. ii, p. 533.

Habitat.—Brought up by a fisherman's hook on a stone with Ascidians, sponges, etc., in the Minch, August, 1865.

Body about half an inch in length, with considerably fewer segments, but of the general shape of a young *F. affinis*, and also enveloped in a gelatinous investment, and

[1] 'Ann. Nat. Hist.,' ser. 7, vol. v, p. 195.

[2] 'Trans. Roy. Soc. Edinb.,' vol. xxxiii, p. 677.

[3] 'Jen. Zeitschr., Naturw.' xlvii, pp. 98—186, 1 pl. and 55 figs.

having the two kinds of papillæ, viz. long urn-shaped, and clavate forms on long stalks (Plate XCVI, fig. 11). It is at once distinguished, however, by its deep brick-red colour, the two long palpi being pale, whilst the branchiæ are of a very deep red. In comparing the urn-shaped papillæ of this form with those of *F. affinis* the only difference appears to be that in *F. buskii* the central granular (hypodermic) axis is more distinct at the tip, a clear granule generally occurring in the centre, whereas in *F. affinis* the whole tip is more slender and the axial substance less evident. The clavate papillæ again appear to be proportionally smaller and the stalk thicker and shorter. Minute sand-grains and other *débris* are attached to the gelatinous investment as in the common species.

The arrangement of the parts at the mouth appears to be similar to those of *F. affinis*, but the branchiæ have a very deep red colour, thus showing that the circulatory fluid has the same tint. The palpi on the other hand are pale.

The frontal bristles (Plate CII, fig. 3) are more translucent and slender than in specimens of *F. affinis* of the same size, and the articulations are longer throughout, as indicated in fig. 8 *a*, Plate CIV, an ordinary bristle being represented in fig. 8.

They have various parasitic growths and are accompanied by the urn-shaped papillæ.

The hooks (Plate CII, figs. 3 *a* and 3 *b*) have a more slender shaft with longer articulations, and the breadth and length of the terminal claw are greater whilst the curvature of the claw and its relation to the shaft differ. When the hook or shaft are broken it separates obliquely at *a*, a little above the articulation, leaving the short process through which the dotted line passes.

Family XX.—Chætopteridæ.[1]

Chætoptériens, *Audouin and Edwards*, 1834.

The head is broad, flattened, but not distinctly separated from the adjoining region. It bears (from the peristomium) two long, grooved tentacles with an eye at the outer base of each. The mouth is large.

Body composed of three regions, an anterior usually of nine bristled segments, some of the bristles being powerful, a middle region of five segments peculiarly modified, and a posterior region of variable length, each segment bearing a large dorsal lobe enclosing acerate bristles and a ventral enlargement with hooks. The fourth setigerous segment has bristles which are specially powerful. Nerve-cords hypodermic in position, wide apart. Tubes of shells, stones, and other fragments lined by a tough parchment-like secretion and comparatively large.

The body-wall, anteriorly (Fig. 111), in *Chætopterus variopedatus*, as Claparède pointed out, is complex, for laterally it is produced into two prominent wings (*al.*) having proportionally large bristles, and from its flattened condition the muscular system undergoes much modification. Externally is a thin ciliated cuticle covering the largely developed hypoderm (*hyp.*) with its spherical or pyriform glands which rest on a

[1] Χαιτη, bristle, and πτερόν, wing.

basement-membrane, thickened in the mid-dorsal line on each side of the median hypodermic ridge. In *C. variopedatus* a longitudinal band of cilia occurs on the dorsum of the first region, and is followed by the ciliated middle region (Lubischew). The hypoderm consists of a series of closely arranged and vertically elongated (columnar) cells, the whole under a low power having a striated aspect. The glands pour out much phosphorescent mucus, to be alluded to subsequently, which Claparède found to render by its mixture an entire basin of water luminous. The same author noted bacilliparous glands in the

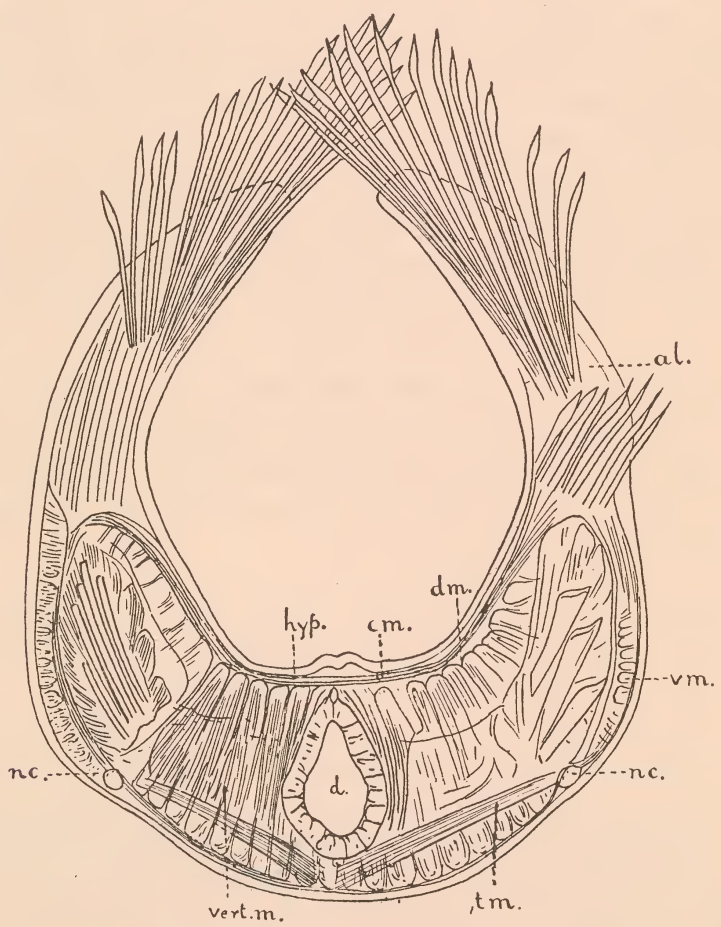

Fig. 111.—Transverse section of the anterior region of *Chætopterus variopedatus*, Renier.

group. The basement-tissue rests ventrally on a circular coat (*cm.*) into which a series of vertical strands run, separated by spaces, and clasping isolated bundles of longitudinal fibres which appear to represent independent muscles (Fig. 111). These vertical fibres fuse into a sheet about one-third of the distance upward, and many pass through the dorsal longitudinal muscles to join the circular layer. Those adjoining the muscular sheath of the alimentary canal mingle their fibres with it. The wing-like process at each side seems to be a modified foot, and the muscles from the bristles likewise spread upward through the dorsal longitudinal at its outer border. The muscles connected with the bristles of the fourth foot are of great strength and fitted for important functions. Those fixed to the bases of the bristles are often separated and thus their actions would appear to be capable of differentiation. A section through the fourth foot and its great bristles

has the form of a horse-shoe, the dorsal region being concave, the ventral convex. The vertical interdigitate with the dorsal and ventral muscles in a most complex manner, special bands of longitudinal muscles occurring between the lateral extensions, the nerve-cord, which is hypodermic, lying in a depression exterior to the insertion of the oblique (*nc.* Fig. 111). The circular muscular layer cuts off ventrally a narrow longitudinal band on the outer base of the lateral wing, and this layer is greatly thickened dorsally. The alimentary canal is comparatively small and surrounded by a sheath of external longitudinal and internal circular fibres. About the eighth segment the ventral hypoderm is considerably thickened, forming the so-called ventral scutes in *Telepsavus* (Claparède). The oblique muscle passes from the outer border of the ventral longitudinal and is attached over the nerve-trunk. A powerful muscle passes from the attachment of the latter to the mid-ventral line (and may represent a continuation of the oblique) where it meets its fellow of the opposite side. Its outer end is over the nerve-trunk in this region. The ventral longitudinal muscles are pushed outward to the wings where they form a compact but rather thin layer along the ventral border of the process altogether beyond the nerve-trunk on each side. The central area for the alimentary canal has a strong inner circular

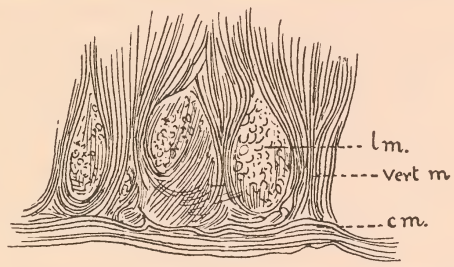

Fig. 112.—Ventral edge of the body-wall of *Chætopterus variopedatus*, Renier, showing the ventral longitudinal muscles clasped by the vertical.

muscular coat and a thicker external layer of longitudinal fibres through which the various fibres from the vertical muscles pass to the circular layer. Moreover, strong bands pass through the circular layer of the body-wall dorsally from this sheath to the basement-layer under the mid-dorsal ridge and they slightly diverge superiorly. The ventral edge of the sheath has no fibres of this kind.

Claparède observes that there is a multiplication of both dorsal and ventral muscles in the thoracic region, yet in the middle and posterior regions only a pair of large ventral longitudinal muscles exist, for the dorsal with the exception of a few isolated fibres disappear. The vertical or dissepimental muscles attain great size in the thoracic region and make sub-divisions by passing through the ventral muscles, the vertical grasping the longitudinal fibres in groups, the whole causing the thickness and firmness of the anterior region.

Toward the end of the anterior region the sheath for the alimentary canal becomes thinner and more free, and the space more capacious.

The blood is colourless in *Chætopterus variopedatus*. In *Telepsavus costarum* a dorsal and a ventral vessel are present, and they are joined by connecting trunks in the form of a reservoir, as in the Ariciidæ. No capillaries were seen. A single trunk appears in the tentacles, and Claparède thought it was a blind vessel as in the Spionidæ. In *Chætopterus* a dorsal and a ventral sinus also exist in the median and posterior regions. The ventral

is small in the thorax, yet large membranous sacs occur on the anterior wall of the dissepiments (Claparède).

The nerve-cords are separated in front and are within the circular coat, but they unite in the middle region, whereas they remain separate in *Telepsavus*. The cerebral ganglia are much diminished, the eyes in both forms being placed on the surface of the transverse commissure.

The segmental organs in the abdomen of *Chætopterus* are conspicuous coiled structures, the upper part of which differs from the lower, having polyhedral cells, with rounded concretions which give a chalky aspect. They lie externally above the great ventral muscle—between it and the ovary. The cavity of the tube is filled with concretions.

Renier [1] gave the name of *Tricœlia variopedata* to this species in 1804 in his 'Prosp. della Classe dei Verm.,' p. 18, and later (1847) a posthumous volume was published, containing a good description with excellent coloured figures both of the animal and its tube. The bristles, however, are on too small a scale for accurate details. In one of the figures (Fig. 6) a pair of peculiar flattened and serrated long lamellæ project from the anterior end as if a longitudinal slit had been made in the first region. The name *Chætopterus* was given by Cuvier in 1830, and has been generally adopted by zoologists.

Busch [2] (1851) describes and figures a larval form from Trieste which most nearly approaches *Spiochætopterus*. The structure of its body and bristles is typical.

R. Leuckart placed this anangian family (as he thought) near the Ariciidæ, but Sars considered it was more closely allied to the Spionidæ, especially, as Claparède shows, after the study of *Spiochætopterus*, *Phyllochætopterus*, and *Telepsavus*. The latter author (1868) draws attention to the occurrence of the special bristles in *Polydora*, *Disoma*, and *Chætopterus*. Notwithstanding Renier's circumstantial account of the vascular system of *Chætopterus variopedatus*, the anangian condition was maintained by various authors.

The free swimming larva of Chætopterus (?) was first described by J. Müller [3] under the name of Mesotrocha; again by Busch [4] and by Max Müller,[5] whose figures, however, show remarkable hooks which differ from anything known in the group. Such figures as Claparède and Mecznikow give of other members of the family indicate that further investigation is necessary in *Chætopterus variopedatus*.

Grube (1865) adopted the family Chætopterea after Audouin and Edwards, placing it between the Chloræmidæ and Arenicolidæ. He entered two species, *C. norwegicus* and *C. pergamentaceus*, but they probably refer to the same form.

The Chætopteridæ formed the first family of De Quatrefage's Sedentary Annelids (1865), which were characterised by having the body divided into regions. He disagrees with Cuvier's location of the group at the end of the Dorsibranchs and near the Polynoidæ. Audouin and M. Edwards, again, raised them to the rank of a family immediately in front of the Arenicolidæ; whilst Grube included them under his Limivora (agreeing

[1] 'Osservazioni postume de Zool. Adriatica del Professore Stefano Andrea Renier,' published under the care of Prof. G. Meneghini, Venezia, 1847.

[2] 'Beobach. Anat. u. Entwickel. Wirb. Seeth.,' p. 59, Taf. ix, figs. 1—8.

[3] 'Archiv Anat. u. Physiol., 1846,' p. 104.

[4] Op. cit., p. 58.

[5] 'Observat. Anat. Verm. Maritim.,' p. 25, Tab. iii, figs. 14—17.

with De Quatrefage's sedentary forms), and placed them between the Maldanidæ and Chloræmidæ; while Leuckart thought they approached the Ariciidæ. The body presents three distinct regions, viz. anterior, middle, and posterior; the middle region he associated with respiration. De Quatrefages had only a single genus, viz. *Chætopterus*, for he placed *Spiochætopterus* under the head of those of uncertain position. Though De Quatrefages could not distinguish blood-vessels on the surface, he considered the regular to-and-fro movements of segments twelve to fourteen as respiratory, the integuments being very thin.

Claparède (1870) draws attention to the prevalence of phosphorescence in this family, and specially describes the condition in *Chætopterus variopedatus*. In his work on the 'Histology of the Sedentary Annelids' he enters minutely into the structure of *Chætopterus* and *Telepsavus*, as already indicated.

The Chætopteridæ constituted the second family of Levinsen's (1883) Syllidiformia Spionina, the first being the Spionidæ, and the succeeding the Cirratulidæ. In this he more or less adopted Malmgren's arrangement, but the other families associated with them do not conduce to a homogeneous group. He arranges the genera thus:—*Spiochætopterus; Chætopterus.*

Joyeux-Laffuie[1] (1890) and Gravier[2] (1909) both describe reproduction of the anterior region in *Chætopterus variopedatus*; the latter giving excellent figures of his example.

Haecker (1896) refers to the Chætopterids as having pelagic larvæ (Mesotrochous).

Benham[3] (1896) grouped the Chætopteridæ as a family of his sub-order Spioniformia, following in the main the classification of Levinsen.

Lillie[4] (1909) experimented with the eggs of this form, and found that the formation of the polar globules was independent of centrifugal force.

The Chætopteridæ are found both between tide-marks and in deep water. The littoral forms inhabit parchment-like tubes, to which are attached fragments of stones and shells, and they are often hirsute with algæ and Zoophytes. In Scottish waters, however, especially on the eastern shores, *C. variopedatus* is a deep-water form, and so with an example procured by the 'Porcupine' of 1870, off Cape de Gatte, in 81 fathoms. In its spacious tube (occasionally 50 cm. long) in the south it has *Polynoë setosissoma*, Sav., *Gattyana cirrosa*, Pallas, and the Polyzoan *Hypophorella chætopteri*, Joyeux-Laffuie, as commensals. Only *Phyllochætopterus*, *Ranzania*, and *Spiochætopterus* were dredged by the 'Challenger.' Their affinities, as Sars observed, appear to be with the Spionidæ.

Genus XCIV.—Chætopterus, *Cuvier*, 1830.

Tricælia, Renier.

Head with the prostomium and peristomium fused, and forming a funnel-like apparatus for the mouth. It gives origin to a pair of grooved tentacles with an eye at

[1] 'Archives Zool. expér.,' 2e sér., t. viii, pl. xv—xx.

[2] 'Ann. Sc. nat.,' 9e sér., t. ix, p. 146, figs. 1 and 2.

[3] *Op. cit.*, p. 323.

[4] 'Biol. Bull. Woods Hole, Mass.,' 1909, p. 52, "Polarity and Bilaterality of the Annelid Egg."

the base. Body large, boldly segmented, and of three regions, as in the family, the anterior region having nine uniramous bristled segments, the fourth segment having powerful bristles in addition to the ordinary forms. Middle region of five segments, with biramous feet, the first segment with great alar lobes, and the last three with fan-like crests. Posterior region with biramous feet, having acerate dorsal bristles and hooks ventrally.

The genus *Chætopterus* was formed by Cuvier for a species from the Antilles. He considered the lamellæ of the middle region branchial in function. It was the last genus of his Dorsibranchiates. Cosmovici[1] holds that it was Dicquemare, and not Cuvier, who first mentioned *Chætopterus*, but this refers to the animal, not the title.

1. Chætopterus variopedatus, *Renier*, 1848. Plate LXXXIX, fig. 3; Plate CII, fig. 5—5*j*—bristles and hooks; Plate XCVIII, fig. 7—tube.

Specific Characters.—About 4 inches in length, of three regions, the anterior consisting of the peristomial funnel and nine bristled segments, the bristles having long shafts, and thin, flattened translucent tips with the outline of a broad spear, the fourth provided with powerful bristles in addition to the ordinary forms, and the last has ventral hooks with eight teeth, whilst the dorsum has a median grooved band. The peristomium bears two long, grooved tentacles with an eye at the outer base of each, some believing that the space between them represents the prostomium. Middle region of five segments, the first with great alar lobes, including bristles, and the last three with fan-like lamellar crests kept in constant motion. With the exception of the first segment of the region, hooks of eleven or twelve teeth occur ventrally. Posterior region of twenty-two or twenty-three bristled segments, each bearing a great dorsal lobe enclosing a series of acerate bristles and swelling into a ventral enlargement bearing hooks with about ten teeth. On the ventral surface are two additional lobes, each bearing hooks with ten or eleven teeth. The body ends in a somewhat lanceolate process on each side and below the level of the anus.

General colour dull yellow, peristomial cavity brownish (madder); first two segments of the middle division with the folded region blackish, and the same tint appears posteriorly in the last three segments.

Tube elongated, contracted at each end, parchment-like, strengthened with shells, shell-fragments, stones and other structures, and often more than half an inch in diameter. Larva a Mesotrocha.

Synonyms.

1778. Le Boudin de Mer, Dicquemare. Obs. sur la Physique, t. xii, pt. 2, p. 285, pl. ii, figs. 2 and 3.
1830. *Chætopterus pergamentaceus*, Cuvier. Règne Anim., ed. 2, t. iii, p. 208.
1835. ,, *norvegicus*, Sars. Beskriv. og Iagttagelser, p. 54, pl. xi, figs. 29*a*—29*h*.
1840. ,, *pergamentaceus*, Grube. Actin. Echin. u. Würner, p. 69.
1844. ,, *norvegicus*, Œrsted. Nat. Tidsskrift., 2 ser., i, p. 414.
,, ,, *pergamentaceus*, Will. Arch. f. Naturges., Bd. x, p. 328.
,, ,, *norvegicus*, Œrsted. Reg. Mar., p. 78.

[1] 'Org. Segment. Annél.,' 1880, p. 74.

1848. *Tricœlia variopedata,* Renier. Osserv. postume, p. 35, Tab. viii.
„ „ „ Meneghini. Ibid., p. 39.
„ *Chætopterus pergamentaceus,* M. Edwards. Cuvier's Règne Anim. Disciples' Ed., p. 42, pl. xx, fig. 2.
1849. „ „ Leuckart. Arch. f. Naturges., Bd. xv, pp. 340—351.
1851. „ *norvegicus,* Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 207.
„ „ „ and *pergamentaceus,* Grube. Fam. Annel., pp. 74 and 136.
„ „ *norvegicus,* Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 207.
1853. „ „ idem. Ibid., vii, p. 390, etc. (Adriatic Fauna).
1855. „ Max Müller. Müller's Archiv, pp. 1—11, Taf. i, figs. 1—8.
1859. „ *norvegicus,* Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 118.
„ „ „ Œrsted. Dröbak, p. 17.
1860. „ *pergamentaceus, norvegicus,* and *Sarsii,* Sars. Förhandl. Vidensk.-Selsk. Christ., pp. 85—87.
1861. „ *norvegicus,* Danielssen. Reise, 1857, Nyt Mag. f. Naturvid., Bd. xi, p. 52.
„ „ *norvegicus,* Sars. Nyt Mag. f. Naturvid., Bd. xi, p. 255.
1863. „ *Sarsii,* Sars. Ibid., p. 302.
„ „ „ and *norvegicus,* idem. Indberetn. Acad. Kongl. Fred.-Universit., p. 50 (sep. copy).
„ „ „ idem. Nyt Mag. f. Naturvid., Bd. xii, p. 302.
1864. „ *pergamentaceus,* Grube. Insel Lussin, p. 85.
„ „ n. sp., Kölliker. Kurzer Bericht, p. 9.
„ „ *insignis,* Baird. Trans. Linn. Soc., vol. xxiv, p. 477, pl. xlix, figs. 1—8.
„ „ „ Williams. Ibid., p. 483, pl. xlix, figs. 7—13.
1865. „ *Valencinii,* De Quatrefages. Annel., ii. p. 210, pl. xii, fig. 1.
„ „ *Leuckartii,* idem. Ibid., p. 216.
„ „ *norvegus,* idem. Ibid., p. 214.
„ „ *norvegicus,* idem. Ibid., p. 657.
„ „ *Sarsii,* idem. Ibid., p. 669.
1866. „ *pergamentus,* Kowalevsky. Entwicklung. d. Rippenquallen, p. 6.
1867. „ *norvegicus,* Malmgren. Annul. Polych., p. 88.
„ „ *Sarsii,* idem. Ibid., p. 88.
1869. „ *norvegicus,* Sars. Christ. Vidensk.-Selsk. Förhandl., 1868, p. 253.
„ „ *Quatrefagesii,* Jourdan. Notici Zool. et Anat. une espèce Chætop., Paris.
„ „ *variopedatus,* Claparède. Annél. Nap., p. 338.
1870. „ „ idem. Suppl. Annél. Neap., p. 125.
1872. „ *brevis,* Lespés. Ann. Sc. nat., 5^{e} sér., t. xv, article 14, p. 1, pl. iv.
„ „ *Valencinii,* Grube. Abhandl. Schles. Gesellsch., 1869–72, pp. 104, 112, 142.
1873. „ *variopedatus,* Claparède. Struct. Annél. Sedént., pp. 70, 88, 98, 101, 102, 126, 127, 135, 136, pl. xii.
„ „ *norvegicus* and *Sarsii,* Sars. Nyt Mag. f. Naturvid, Bd. xix, p. 261.
„ „ „ „ idem. Bidrag Christ. Fauna, p. 61.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
1875. „ *variopedatus,* Marion and Bobretzky. Ann. Sc. nat., 6^{e} sér., t. ii. p. 86.
1875. „ *norvegicus,* McIntosh. Invert. and Fishes St. Andrews, p. 126.
„ „ *variopedatus,* Panceri. Atti R. Accad. Sc. Napoli, vol. vii, p. 1, Tav. i.
„ „ „ idem. Atti Soc. Ital., vol. xviii, p. 528.
1877. „ „ Grube. Monatsber. Köngl. Akad. Wiss., Berlin, p. 511.
1879. „ *norvegicus,* Tauber. Annul. Danica, p. 114.

1880. *Chætopterus Valencinii,* Cosmovici. Arch. Zool. expér., t. viii, p. 306, pl. xxvi, figs. 1—17.
1882. „ *pergamentaceus,* Verrill. U.S. Comm. Fish and Fisheries, x, p. 665.
1883. „ *norvegicus* and *Sarsii,* Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 108.
1884. „ *variopedatus,* Delage. Bull. Soc. Linn. Normand., 3e sér., t. viii, p. 376.
1885. „ „ Carus. Fauna Medit., p. 257.
1886. „ „ Giard. Bull. Sc. Nord. France, 2e sér., t. ix, p. 335.
1887. „ „ Sirodot. C. R. Assoc. franç. l'avanc., etc., 1886, 1e part, p. 160.
1890. „ „ Joyeux-Laffuie. Arch. Zool. expér., 2e ser., t. viii, p. 244, pls. xv—xx.
„ „ „ Malaquin. Annél. Boulonn., p. 47.
1891. „ *insignis,* Hornell. Trans. Biol. Soc. Liverp., vol. iii, p. 158.
„ „ *pergamentaceus,* Andrews. Proc. U.S. Nation. Mus., vol. xiv, p. 290.
1893. „ *variopedatus,* Lo Bianco. Atti R. Accad. Sc. Nap., 2 ser., vol. v, No. 11, p. 35.
1894. „ „ De St. Joseph. Ann. Sc. nat., 7e sér., xvii, p. 147, pl. vii, figs. 189—199.
„ „ *norvegicus,* Bidenkap. Christ. Vidensk.-Selsk. Förhandl., 1894, No. 10, p. 96.
„ „ *Sarsii,* idem. Ibid., p. 97.
1896. „ *variopedatus,* Benham. Camb. Nat. Hist., vol. ii, p. 323.
1897. „ „ Ehlers. Hamb. Magel. Samm., p. 109.
„ „ *Sarsii* and *norvegicus,* Michaelsen. Polych. deutsch. Meere, p. 156.
1900. „ *variopedatus,* Ehlers. Schwed. Magell. Annel., p. 15.
1901. „ „ idem. Polych. Magell. u. Chil., p. 182.
1904. „ „ Crossland. Proc. Zool. Soc., 1904, i, p. 270.
„ „ „ Journ. M. B. A., vol. vii, p. 228.
1906. „ „ Gravier. Nouv. Arch. Mus. Paris, 4e sér., t. viii, p. 186, pl. iii, figs. 205—208.
1908. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. ii, p. 533.
1909. „ „ Fauvel. Bull. Inst. Ocean., cxlii, p. 17.
1912. „ „ Crawshay. Journ. M. B. A., vol. ix, p. 343.
1913. „ „ Giard. Œuvres Div., p. 57.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, pt. 47, p. 106.

Habitat.—Dredged off St. Peter Port, Guernsey, in 15—20 fathoms on ground composed of gravel and shell *débris.* Those procured at Herm under stones in certain pools between tide-marks have shorter tubes than those stuck in sand and gravel, and which are only got at spring-tides. In Lochmaddy numerous tubes were attached to tangle-roots throughout the bay, and a living example occurred in Ardmaddy Bay between tide-marks. The tube is occasionally contracted at one end. Shetland, tubes of parchment or coated with grey mud; and off the Hebrides, small parchment-like tubes (J. G. Jeffreys). St. Andrews Bay, tubes are not uncommon and occasionally a living example; stomach of haddock, St. Andrews (E. McIntosh); 15—30 fathoms S.W. of Peel; Plymouth (Spence Bate and Rowe); Firth of Clyde (D. Robertson); forty fathoms off the coast of Cornwall, Polperro, Beaumaris, Anglesey (Dr. Baird). The tubes are largely coated with mud, from which algæ and long tufts of *Obelia* spring (W. C. M.). Birturbury Bay, Ireland, in beam-trawl (A. C. Haddon); S. W. Ireland, log. 31, 39½ fathoms amidst *Cellepora* and Nullipores (R. I. A.); Aran Islands (E. P. Wright); Clare Island district (Southern).

Foreign localities are Norway, Sweden, and Finmark (Malmgren). Shores of France, Mediterranean (Marion and Bobretzky, De St. Joseph). Adriatic and Naples (Grube,

Panceri, etc.). Red Sea, etc. (Gravier and Crossland); 9 miles off Cape de Gatte, 81 fathoms, 'Porcupine,' 1870; 300 fathoms off Norway (Sars). Strait of Magellan (Grube and Ehlers). Chili (Ehlers). Mediterranean—Naples (Lo Bianco). Three hundred fathoms off Norway (M. Sars). Spitzbergen (Fauvel). Almost cosmopolitan.

The anterior region in the northern specimens usually consists of the "head" and nine bristled segments. The so-called "head" forms a broad frill or collar, the great dorsal flaps of which cease at the base of the tentacles, a less conspicuous rim passing on each side to the middle line of the dorsum where fusion occurs. In the preparations of the northern forms, as in life, no forward frill is present in the mid-dorsal line, as in the Neapolitan examples, the dorsal band forming an enlargement and ending bluntly behind the oral rim (funnel). In the Neapolitan form the dorsal median line has a tendency to differentiation in the shape of a fold or a thickening of the rim, and the termination of the mid-dorsal longitudinal band is less expanded. The cavity of the collar, which, by the approximation of the dorsal flaps, assumes the shape of a funnel, leads to the mouth and is tinted brown, with a tendency to madder-brown near the mouth. It doubtless subserves important functions in alimentation. At its outer edge dorsally and close to the first foot on each side springs the large subulate tentacle (peristomial cirrus) which in the preparations is grooved and crenated on its inner surface. Thus the organ resembles a palp, though apparently occupying a different position. In life it is capable of considerable elongation and occasionally presents a coil or two toward the tip. At its base externally and anteriorly is a transversely elongated black or dark brown pigment-speck—the eye. In the preparations it occupies a pit at the base of the collar and between it and the origin of the tentacle. In some the black pigment-specks are separately arranged in a transverse row. The space between the tentacles has by some authors been considered to represent the prostomium.

Closely following the buccal segment are the feet and other parts of the first or anterior region of the body (to which also the buccal segment belongs). In almost all the northern examples, and these range from Shetland to the Channel Islands, the number of bristled segments is nine. In two examples of *C. variopedatus* from Naples, one had ten on both sides, and the other ten on the right and eleven on the left side. Considerable variability, however, is known to exist in the common species, which may have only eight bristled segments in this region, as Claparède found in certain Neapolitan examples. The feet are uniramous with the exception of the ninth, and to some extent increase in length from before backward. Each is a sickle-shaped process directed outward and upward nearly at right angles to the body and carrying a long row of bristles on its convex or ventral edge, whilst at the base dorsally is an elevation like a bulla from the third foot backward. It thus differs from the condition in the examples from Naples, where the glistening dorsal coat forms a concave fillet at the base of each foot, and there is no bulla, the latter being visible even in small specimens of the northern form. Yet on pressing the broad dorsal layer in the Neapolitan examples a bleb is caused on the thin covering of the foot just beyond it, so that a different mode of preparation might cause resemblances. This region in the large examples forms a mass which in the spirit-preparations is nearly quadrangular and of almost cartilaginous hardness. The feet vary to some extent from the first to the ninth, though retaining the general plan. The eighth is perhaps the longest, whilst the

ninth is considerably shorter. All except the fourth possess the same armature of bristles, which, from the curvature of the foot (the line of the bristles being on the convexity), are thus brought into contact with the wall of the tube. At the free extremity of the setigerous region are one or two bristles having long, slender, tapering tips with a trace of a wing, thus indicating the type of which the others below it are modifications (Plate CII, figs. 5, 5 *a* and 5 *a'*). The tip gradually flattens into a thin, translucent, yellowish blade shaped like a pointed spatula, and the shaft increases in thickness till, at the inner or ventral end of the row, the organ is almost foliate at the tip, and is not quite symmetrical (Plate CII, figs. 5 *b*, 5 *c*, 5 *d*, 5 *e*, 5 *f*). As De St. Joseph and Mr. Crossland [1] have pointed out, such a bristle has little piercing power, but is admirably suited for application to the inner surface of the tube as a flexible brush and lever. They are arranged in the foot (Plate CII, fig. 5 *g*) in the form of a long fan of bristles, the shafts of those at the tip, that is at the extreme outer border of the fan, crossing the shafts of those at the concave or dorsal edge of the foot (Plate CI, fig. 2). The seventh or eighth appears to possess the longest row of these bristles.

In addition to the foregoing (dorsal) series the fourth foot has ventrally a row of stiff, chitinous, tooth-like bristles (eight) of a deep brown colour. The brown shaft dilates at the tip, and is strengthened by a thick coat of chitin, whilst one edge of the truncate tip is prominent, the whole forming a tooth-like process (Plate CII, figs. 5 *h* and 5 *i*) fitted either to act as a lever or as a support. In the row in any individual the tips vary, the stronger being dorsal and the less robust ventral or inner, and they also show age-variations.

The ninth foot, from its size, has a considerably shorter row of the ordinary bristles, but they do not diverge in structure. Moreover, a hatchet-like (De St. Joseph) ventral lobe is appended to its inner edge inferiorly. This bears an armature of hooks (Plate CII, figs. 5 *j* and 5 *k*), which have an elongate form like those of the Ampharetidæ, and show as a rule eight recurved teeth and a rounded "prow" for the attachment of the larger ligament. Some (Herm, Cornwall, etc.) have a minute ninth fang at the commencement of the series.

Whilst the dorsal surface is distinguished by its narrow median grooved band, which (as a grooved band) is continued on the tenth bristled segment, the ventral surface forms a large convex, glandular, shield-like area somewhat resembling that in *Sabella*, and in the Neapolitan examples the area is more definitely outlined, probably from the method of preparation.

The middle region consists of five segments, though it may be a question whether the first, *viz.* that with the great wing-like lobes, does not pertain as much to the anterior region. This segment has dorsally the median grooved band (ciliated) which has the same diameter as in front, but at the posterior edge of the wings it diminishes and is continued thereafter as an undivided smooth band. Moveover a whitish convoluted triangular mass with its base applied to the grooved band, and its twisted apex extending more than half-way along the great wing, occupies the dorsum of this segment, and appears to represent the secretion of the region. The feet of this segment form great alar expansions of which the anterior half in each is supported by a large fan of bristles,

[1] 'Proc. Zool. Soc.,' 1904, i, p. 271.

whilst the posterior part is devoid of them, and is probably therefore the more mobile. When the superficial tissues are removed this posterior region of the wing presents a tapering hollow tube which is elastic and glistening like a thin sheet of cartilage, but it is really composed of a highly elastic fibrous sheath, and probably has a fluid driven into it internally. The bristles supporting the web in front are of the type characteristic of the posterior region, *viz.*, long, straight bristles tapering at both ends and fixed throughout to the muscular web. The base of these great wings is crowded with glands for the secretion of the abundant mucus. Their dorsal surface is grooved and ciliated, food being thus carried forward by the median ciliated band to the funnel-like mouth.

The ventral division of this foot has united with its fellow of the opposite side to form a transversely elongated disc like a sucker with the hooks on the frill-like edge. In some there are indications of a median separation, but in others only a slight indentation of the outline occurs—the row of hooks being continuous, and they do not differ essentially from those of the ninth foot, but many show the small ninth tooth, and a small process for the attachment of the ligament projects at the opposite side.

The next segment resembles a portion of gut with a soft transversely reticulated wall having the raised median band continuous with the grooved one in the previous segment, and with deep folds like those in the colon. The dorsal median band continues backward to a curiously frilled whitish or yellowish structure which separates the segment into two moieties, and which forms two flaps in front with a central circular opening and a projecting pouch posteriorly containing sand-grains and muddy matter—apparently contents of the gut with sponge-spicules, bristles, and fragments of shells. Whether this acts as an escape-valve, accidental or otherwise, cannot be ascertained from the preparations, but appearances suggest such a view. The two firm, whitish dorsal flaps of the organ open forward, and have within them a second yellowish fold on each side, within or behind which again is an opening of considerable size, bounded inferiorly by a tense band. The raised dorsal median band passes to the base of this tense band where a slight fillet occurs and then ceases. The moiety of this segment behind the folded organ resembles that in front of it, minus the median dorsal band, and dipping down behind becomes continuous with the third segment of the region. Ventrally two great muscular masses with a deep median groove give firmness to the region and support the muscular ventral disc bearing the hooks, the form of the disc resembling that in front.

The three following segments resemble each other in so far as each is somewhat urn-shaped, narrow posteriorly and rising anteriorly and dorsally into a great fan-shaped surface, the edge of which forms a broad frill or collar. The anterior surface is firm and muscular, whilst the posterior shows the gut through its thinner walls. The broad collar is continued in each ventrally so that it is complete. From the mid-ventral edge of the collar is given off the nearly quadrangular disc for the hooks which are borne on the free flap posteriorly. A trace of a median division is present. The next segment bears a broader disc more distinctly bilobate, and so is the disc on the last segment of the region. In short, each of the two just mentioned clearly foreshadows the two free pads for hooks in the succeeding segments. The hooks of the last segment of the region

differ from those in front for they have eleven or twelve teeth (Plate CII, figs. 5 *j* and 5 *k*).

It is in this region, *viz.* the eleventh segment, that the cylindrical fæcal masses first appear, so that they must be formed in front of it. The inner surface of the gut is here thrown into a complex series of folds or large villi, but no evidence of the method by which these fæcal masses are formed is visible.

In a living example from St. Andrews, kindly brought by one of the fishermen, the three great lamellæ on the dorsum of the middle region of the body are waved to and fro as if performing a respiratory function, either for blood or cœlomic fluid. The tentacles are also slowly waved to and fro, now stretched a little and now contracted. The muscularity of the three great lamellæ is considerable, and they move with a vigorous fanning motion from front to rear. Waves of what seem to be cœlomic fluid distend these organs in a somewhat regular manner, so that the movements may be respiratory.

The general colour is dull yellow, deepest on the first region of the body, which also presents a faint madder-brown tinge along the oral flap in front. The two greatly modified feet, which pass forward as dorsal fans, represent the dorsal division of the tenth bristled foot. Below the ninth a pale flap on each side passes inward toward the middle line, a gap moreover separating it from its neighbour. It bears a border of hooks and probably corresponds to the ventral division. The pair below the alar dorsal processes which next follow, unite by their anterior border in the middle line, which is frilled, and their outer border bends round and joins its fellow also, so that a hollow flap or basin is formed with the hooks as a margin all round. A tendency to a median separation is indicated by a depressed part in front and rear. The next ventral flap has a similar arrangement only it is larger. On the dorsum above these are the dark greyish folds of the crenated gut, which in the specimen were interrupted by a bilobed pale fold continuous laterally with the second ventral flaps just mentioned. Between this and the next process is a brown median line on the ventral surface. The next ventral flaps are smaller and differently arranged, projecting ventrally as free bifid lamellæ continuous at each side with the first great median dorsal flap. The posterior wall of the flap is distended by a greyish mass as if the gut communicated with it, but whether from rupture or otherwise is undetermined. The margins of these three great dorsal lamellæ can be crenated in contraction. Massive bifid ventral flaps occur on the second and third lamellæ, and their prominent margins bear the hooks.

The next segment has dorsally a pair of long and slightly curved lanceolate lamellæ tapered toward the tip, and having the bristles internally. They would thus correspond to the dorsal division of the foot. The inner edge is connate with that of the opposite side. The ventral division seems to be split into two, the upper forms a lanceolate process attached to the base of the former, and with a line of golden hooks inferiorly; the lower forms the ventral flap also with its line of hooks; and so on the other side, the processes being double. There are apparently fifteen segments posteriorly bearing these processes, besides the terminal pair, also having bristles, on each side of the dorsal anus. The dorsal processes are large and prominent in the anterior part of this region, diminish gradually to shorter and narrower lamellæ, which, however, preserve

the same shape, the outer edge showing an inward curve and then a convex portion, from which it tapers distally. The bristles are enclosed in the process, which assumes a slightly angular outline when seen from the tip. These organs are muscular, and perform various movements, while they are likewise very sensitive. All show a characteristic curve dorsalward.

The ventral lamellæ bearing the hooks undergo even more marked changes posteriorly, the lateral flap appended to the side of the dorsal becoming short and almost filiform, leaving the side of the dorsal process, and being appended to its base in front, the pads or flaps for the hooks on the ventral surface being small.

The posterior region has twenty-two or twenty-three strongly-marked segments, each of which has a prominent dorsal division of the foot formed on the plan of the great wings of the tenth segment, *viz.*, a large fleshy lobe somewhat tapered distally and enclosing a series of long and strong bristles tapered at both ends, but with the distal most attenuate, indeed of the type seen in the tenth bristled segment. This process ends in a ventral enlargement carrying on its anterior edge a band of hooks each of which has about ten teeth. Besides, on the ventral surface are the two flaps bearing hooks with ten or eleven teeth. Altogether there are thus four rows of hooks in each segment, and the hooks individually vary little in the several rows. The dorsal divisions gradually diminish posteriorly, and end in two small and somewhat lanceolate processes on each side, below the level of the anus.

The tubes are composed of a tough secretion which hardens into a leathery case which is spindle-shaped, being wide along the greater part of its length, but narrowed toward the finished opening at either end, and it is strengthened externally by fragments of shells, algæ, stones, mud, and other *débris*. Internally it is smooth. Its width enables the annelid to reverse itself, so as to make the finished apertures at the ends. Some large tubes are $8\frac{1}{2}$ to 9 inches long. Occasionally the tubes are feathered with *Obelia* and other zoophytes (Plate XCVIII, fig. 7), or bound in a mass of *Cellepora* and *Serpulæ*, with adherent Ascidians, nullipores, young *Balani*, fragments of shells, and *Spatangi*, amidst the crevices of which Ophuiroids and small annelids lurk, and on the flat surfaces of which *Lepraliæ* spread their net-work of lace. Some tubes are mostly protected by broken shells and often bent like a siphon. Shells, stones, and fragments of *Balani* were common on the tubes between tide marks at Herm.[1]

It is most beautifully phosphorescent, bright flashes being emitted from the posterior feet, but the most vivid light occurs on the dorsum between the great sickle-shaped lobes which curve forward over the first region of the body. Here the phosphorescence is intense, and the copious mucus exuded by the animal can be drawn out as vivid bluish-purple fire which, besides, now and then gleams along the edges of the wing-like flaps, illuminating the water around. This point, moreover, seems to be the last to show the phenomenon when the specimen is moribund. The bluish-purple light seemed to approach that of burning potassium, and an odour resembling that of phosphorus was felt during the experiments. The tough secretion hardens into a firm, whitish mass in spirit.

[1] Mr. Orton states that at Plymouth a specimen not thirteen months old constructed a tube 14 cm. long, and had developing ova in its gonad, 'Journ. M. B. A.,' vol. x, p. 316, 1914.

When removed from its tube the annelid lies coiled on the bottom of the vessel, the tail being curved to the middle region. When disturbed in its tube the two tentacles are sometimes protruded.

In the tubes on the south coast of England *Nychia cirrosa* accompanies this species as a commensal, and Ray Lankester gives *Harmothoë sarinense* (= *Lagisca floccosa*, Sav.) and *H. Malmgreni* (= *H. setosissima*, Sav.) in the same tubes at Herm, whilst Hornell found the latter form at Beaumaris.

Reproduction.—At Naples, where it is termed "Ricce rinte o tube," the period of sexual maturity ranges from May to September (Lo Bianco).

The larva (which Lo Bianco found at Naples from February to July) is mesotrochal, with a ciliated ring round its middle, the region in front of the ring giving rise to the anterior division of the body, whilst that posterior to it develops into the two succeeding regions.

De Quatrefages (1865) formed a new species for examples from the coast of Normandy, but such do not differ from the common forms, and the same may be said of his *C. Leuckarti* from the Adriatic.

Dr. Baird, in 1864, described this as a new species under the name of *C. insignis*, but, as his specimens show—for he was so kind as to send examples—it was only the confusion of previous authors which caused the ambiguity.

R. Leuckart pointed out that authors have mistaken the dorsal for the ventral surface of *Chætopterus*. He found *Modiola* parasitic in its tube. He was inclined to place it with the Ariciinæ, since it agrees in the rudimentary development of the head, and has a somewhat similar body with appendages. Its ventral hooks are akin to those of the Capitellidæ, yet *Chætopterus* is a higher form.

Lespés[1] (1872) gave a sketch of the structure, apparently of the common species, procured on the shores of Provence, which form, however, he terms *C. brevis*. He found no trace of a circulatory system, and the male segmental organs which are in the posterior segments have the shape of a grooved funnel, which joins a tube opening externally, whereas in the female it is an opaque organ without an internal funnel.

A careful account of the phosphorescence of this form was given by Panceri (1875), including the phosphorescent glands of the pinnules and other parts, his conclusion being that the luminosity resided in special cells of the external epithelium, especially in the glands of the pinnules and pyriform elements of the ciliated epithelium elsewhere.

Cosmovici (1880) states that the organs of Bojanus are closely connected with the segmental organs, and that they possess external apertures, but apparently the only internal aperture is that of the segmental organ with which it communicates, and which, he states, opens into the intestine. These organs occupy the three dilated portions of the middle region. The author, thus, was in error in regard to the structure of the parts. He describes the genital glands as in the form of a loop in the same region of the body, one end being fixed to the intestine, the other free. The ova or sperms are shed into the cœlom and find exit by the segmental organs. These organs—a pair in each segment—likewise occur in the posterior region of the body in the same close connection, the organ

[1] 'Ann. Sc. nat.,' 5e sér., t. xv, art. 14, p. 63.

of Bojanus having its external opening on the pinna, but he does not specially describe the supposed opening of the segmental organ into the intestine. The author thus introduced considerable confusion into the description.

A curious observation was made by Verrill[1] (1882), viz. that *Chætopterus pergamentaceus* at low water, at Nanshon Island, enlarges its tube by making slits in it, then, spreading it out, fills up the "gore or gusset" with fresh secretion.

Béraneck[2] (1894) describes the larval *Chætopterus* as having its feet developed early, and, with the ciliary crowns, acting as locomotor organs during the prolonged pelagic stage. He thinks the ancestors were probably free, and in becoming sedentary the posterior region has been specially modified. The setigerous processes extend along half the body in the young, but in the adult they occupy only a sixth.

An interesting account of the green colouring matter of the intestinal wall (middle region) is given by Ray Lankester[3] (1897), in which he shows that it differs from Bonellin, and hence the name Chætopterin is appropriate.

Gravier[4] (1904) notes the discovery of a nucal organ in a new *Telepsavus* in the form of a small process on the surface of the prostomium on each side, between the insertions of the tentacles. These processes resemble the lappets of *Autolytus*.

The same author,[5] in his Red Sea Annelids, describes a variety of *Chætopterus variopedatus* distinguished only by the small number of the segments of the posterior region. In a ripe female he found a curious external appendage in the middle region, with a rounded extremity and a flask-shaped base, which he associated with the segmental organ, being situated immediately above its orifice, and he thinks that it is connected with the issue of the ova.

Delagia Chætopteri, a curious Polyzoan with creeping stolons, was found on the inner surface of the tube of *Chætopterus* on the shores of France by Joyeux-Laffuie[6] (1888).

Genus XCV.—PHYLLOCHÆTOPTERUS, *Grube*,[7] 1863, *Char. emend.*

Cephalic lobe small with a grooved ridge in the mid-dorsal line. Buccal funnel somewhat like that of *Chætopterus variopedatus*. Tentacles two pairs, unequal, simple, the shorter with an internal bristle. Eyes two, lateral in position. Body of three regions, the anterior being flattened and with ten pairs of well-marked simple feet furnished with bristles having spear-shaped tips. The fourth is longer than the others, and bears a single, powerful chitinous bristle resembling a molar tooth and beyond it a short row of bristles with flattened hastate tips. Eleventh bristled segment (first of the second or middle region) has two dorsal branchiæ, a flattened lobe in the lateral region, and below

[1] 'Rep. Comm. Fish and Fisheries, U.S.A.'
[2] 'Rev. Suisse Zool.,' t. ii, p. 377, 1 plate.
[3] 'Quart. Journ. Micr. Sci.,' vol. xl, N.S., p. 447, 4 pls.
[4] 'Comp. Rend. Acad. Sc.' Paris, t. cxxxix, p. 545.
[5] 'Nouv. Archiv. Mus. Paris,' 4e sér., t. viii, p. 186.
[6] 'Arch. Zool. expér.,' 2e sér., t. vi, p. 115.
[7] 'Archiv f. Naturges.,' Bd. xxix, p. 54.

it ventrally is the torus for the hooks. Posterior region has also biramous feet, with slender dorsal bristles and ventral hooks.

Tubes for the most part translucent and ringed, and in the case of a budding form recently described by Mr. Potts are branched.

De Quatrefages (1865) was of opinion that this genus and *Spiochætopterus* were identical.

Claparède (1868) points out that the presence of the second pair of tentacles distinguishes *Phyllochætopterus* from *Spiochætopterus*, though the two genera closely approach each other.

1. Phyllochætopterus gracilis,[1] *Grube*, 1863. Plate CII, fig. 6—6 *b*—bristles and hook; Plate CVIII, fig. 15—tooth-like spine of fourth segment.

Specific Characters.—Anterior region with the buccal funnel somewhat like that of *Chætopterus variopedatus*, but a grooved ridge runs backward in the mid-dorsal line, the ridge having a swelling or "boss" in front. The palpi are absent (from injury), and just behind is a small and somewhat clavate tentacle. A median band runs along the convex dorsum of the muscular region, whilst ventrally a whitish band and a whitish transversely elongated area behind enliven the surface. Ten pairs of well-marked feet in the anterior region, the first directed forward, each with a row of bristles with thin, flattened spear-shaped tips. The fourth foot is larger than the others, and bears ventrally a single powerful chitinous bristle resembling a long molar tooth; beyond it is a short row of the bristles with the flattened hastate tips. Hooks unknown. Eleventh bristled segment (first of the second region) has two dorsal branchiæ, with an even margin internally and a slightly enlarged tip, the external border having a crenate process or branch. A flattened lobe on the lateral region below it; ventrally is the transverse pad for the hooks (which are absent in the example).

Synonyms.

1863. *Phyllochætopterus gracilis,* Grube. Archiv f. Naturges., Bd. xxix, p. 52, Taf. v, fig. 4.
1868. ,, ,, Claparède. Annél. Nap., p. 345.
1881. ,, ,, Langerhans. Canarisch. Annel., p. 114, Taf. v, fig. 19.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870 in 81 fathoms off Cape Finisterre.

A fragment, scarcely $\frac{3}{8}$th of an inch in length and about $\frac{1}{8}$th of an inch broad, of the anterior region of a form that at first sight most nearly approaches Claparède's genus *Ranzania*, seeing that no long tentacles are present, but their absence is probably due to injury and therefore it may be *P. gracilis*. The snout resembles that of the common *Chætopterus variopedatus*, for the lower lip is less prominent, but the presence of two

[1] This differs from *P. socialis,* which has thirteen bristled segments in the anterior region, and the posterior region commences at the twenty-fourth, and has thirty-five segments. The tubes are grouped and transparent.

small tentacles on each side of the median fold of the rim of the oral funnel dorsally corresponds with *Phyllochætopterus*. The anterior region, which, fortunately, is complete, consists of ten bristled segments and only a single segment of the succeeding region remains.

The buccal segment shows a prominent thick rim all round, the ventral part, however, being not more so than the dorsal, which forms a transverse projection from which a grooved ridge runs backward and ends in a point. At first sight this appears to be only a fold of the buccal funnel, but closer inspection reveals that it is a specially differentiated structure, the anterior ends of the ridge on each side ending in a small, rounded boss, to the exterior of which, and in front of the short tentacle, is an area with a minute papilla or two which may represent the site of the large tentacle (palpus), now removed. The smaller tentacle on the left is somewhat subulate, but that on the right is widened a little below the tip so that it is more or less clavate. They are somewhat widely separated at the base in the preparation, lying just behind the little papillæ indicating the palpi, but considerable distortion often follows preservation. From the apex of the grooved ridge at the anterior border of the dorsum a median band extends along the firm convex muscular surface to the posterior border of the region, and the feet on each side are boldly marked. Ventrally the preparation shows a slightly flattened surface, equally firm. Anteriorly the lower lip is dark grey, a whitish band follows, and then another dark grey area covering two segments. A transversely elongated whitish area succeeds, occupying the site pertaining for the most part to the sixth feet. The ventral region behind this patch is a shade lighter than the grey area in front.

With the exception of the fourth the ten pairs of uniramous feet are nearly uniform in appearance, the first pair, however, being directed slightly forward, as are also its bristles. Each foot as a rule is directed outward and slightly upward, the row of bristles running from the base ventrally along the prominent ridge, inclining backward a little at the tip, and ending in the more slender series there. The bristles of the first foot had been broken or abraded, only one or two of the tips—flattened, translucent, and gently tapering to a flat spear—being present.

The fourth foot is larger than the rest and the free end is truncated. It bears ventrally a single, large chitinous bristle resembling a long molar tooth (Plate CVIII, fig. 15), the tip being enlarged and very hard as well as brittle. Its long and strong shaft is deeply inserted into the tissues and its muscles are strong. Below the bristles is a papilla with dots. Above it is a short row of the bristles with thin, hastate, or almost foliate tips, the direction being upward and slightly backward.

In general the bristles of the region commence ventrally with a regular series in the form of a fan, the bristles being arranged in a row close together and up to the end of the shaft, only a fragment thereof, as a rule, projecting beyond the tissues (Plate CII, figs. 6 and 6 *a*). The flexible lanceolate tip will thus yield as the foot is applied to the wall of the tube, whilst the powerful tooth-like bristle of the fourth segment will securely fix it anywhere. The tips become more elongated and acute toward the extremity of the foot, and, for instance, in the tenth foot the distal series in the preparation forms a separate group, the shafts of which cross the great fan at an angle, and from their position project much further outward and upward. The tips of these are narrow, elongated, and finely tapered (Plate CII, fig. 6 *b*).

The tenth segment has at its posterior border dorsally a subulate median papilla, at which the median dorsal band apparently terminates. The base of the papilla is somewhat globular, and from this the subulate process extends.

The eleventh segment has dorsally two branchial processes which have an even margin internally and a slightly enlarged tip, the external border having a crenate process or branch. On the lateral region beneath is a flattened lobe somewhat clavate in outline on its broad side. Ventralwards is the transverse eminence for the hooks, but unfortunately none remain in the specimen.

Reproduction.—A large example had numerous ripe ova in clusters on its surface in the tube in September. Lo Bianco (1909) met with the pelagic larva of *Phyllochætopterus* from June to December at Naples.

The larva of the *Phyllochætopterus* is described and figured by Claparède and Mecznikow (1868) in the mesotrochal stage, with two large and four smaller eye-specks in front, two short tentacles, and a prominent lower lip, followed by a series of bacilli in cells, two median rings of cilia, three other segments with projections, and a long caudal contractile style with two enigmatical organs at the base, which at first sight resemble herniæ with bacillary cells. The larva of *Telepsavus* has a shorter caudal process.

So far as can be judged from this imperfect example, it is probably the anterior region of *P. gracilis*, Grube.

The tube of *P. socialis*—whether social or solitary—is unknown, so that no opportunity of solving the uncertainty of Claparède in relation to the condition of his at Naples was afforded. The latter forms extensive masses ("*prairies*"), the tubes being inhabited mostly by one sex, *i. e.* males, whilst the females are rare, and what is more remarkable is the fact that several occur in each tube, as if budding had taken place, the anterior or upper alone projecting its tentacles from the aperture. Claparède could not satisfy himself as to whether the posterior examples could project from branches of the main tube. In the description of *Phyllochætopterus Claparedii* in the 'Challenger' Annelids[1] it was stated that an apparent bifurcation of the tube was not uncommon, a few of them showing a series of such regenerations so as to resemble the polypary of a Sertularian.

In an interesting communication to the Dundee Meeting of the British Association Mr. Potts (1912) gave the life history of a *Phyllochætopterus* from the shallow water of Vancouver Island. The long, creeping, horny, narrow, unbranched tubes, which have various openings, are inhabited by several individuals, apparently formed asexually by detaching the posterior region of the body which regenerates the middle and anterior regions.

Spiochætopterus.—Tubes apparently of this form have been procured in St. Andrews Bay (E. McIntosh) dredged in Loch Linnhe in 35—37 fathoms; and thirty miles west of the Blasquet in 110 fathoms (J. G. Jeffreys); but no example of the annelid has been obtained.

[1] P. 376.

Family XXI.—Spionidæ, *Sars*, 1861. Spiodea, *Grube.*

Cephalic lobe small, with an entire incised or bilobed margin, or two pseudo-tentacles, eyes often present, frequently four; so-called tentacles present or absent, generally largely developed. Body as a rule small, rounded, translucent; segments numerous, short, an anterior one sometimes armed and distinct from the rest, bearing paleæ. Buccal segment nude; proboscis slightly differentiated, and seldom extruded; anus dorsal, surrounded by cirri, or papillæ, or with a sucker. Branchiæ variable, simple, ligulate, lanceolate, or cirriform, sometimes absent. Branchial vessels simple, lamella of the foot often continued along the branchia. Feet generally biramous, lamella behind the double row of bristles, which are capillary with wings. Hooks with elongated shafts and wings, the tip with one or more points above the main fang. Nerve-cords with a neural canal.

In Montagu's MS. Volume[1] (1808) in the Linnæan Society's Library, with drawings by his niece, Miss E. Dorville, figures are given of two forms, under the names of *Pasithoë bilineata* and *P. carnaria*, which closely resemble *Nerine*. Both have a pointed snout like that of *N. cirratulus*, and the colour of the former is greenish.

Part of the forms under the Spionidæ were placed by Audouin and Edwards (1834) under their "Ariciens," viz. *Scoloplos* and *Nerine*, whilst *Spio*, *Polydora*, and others were relegated to an appendix in company with *Campontia* (a larval insect).

Œrsted[2] (as in his Annulat. Danic. Consp.) included the Spionids under his Ariciæ, the second family of his Chætopoda terricolina, and under his sub-division Ariciæ naidinæ, the distinctive characters being the presence of two long tentacles; pinnæ and branchiæ arranged dorsally, rarely laterally; eyes 2—6 or more. Small translucent forms of the Ariciæ which approach the Naides and Lumbrici. He refers[3] to *Spione trioculata*, which, besides bearing two frontal processes like *Scolicolepis*, has bifid tentacles and only three eyes. It may have been an abnormal form.

Amongst the larvæ described by Kröhn and Schneider[4] is one with a facetted surface, but resembling an early *Nerine* larva.

The representatives of this family (Spiodea) were placed by Grube (1851) under the Ariciidæ, after Audouin and Milne Edwards, along with the Cirratulidæ and the Sphæodoridæ.

Various Polychæt larvæ were described by Busch[5] (1851), and amongst others a form (Taf. viii, figs. 1—4) which is most nearly related to the Spionidæ. The long provisional bristles are in front, and about thirty segments follow. Other larvæ either belong to this group, or may represent those of *Owenia*.

In *Nerine beata*, Dr. T. Williams (1858) shows a germ-mass attached to the ciliated tube (Plate VIII, fig. 19) which it embraces. He, indeed, contended that the "segmental

[1] Pl. xix, figs. 1 and 2.
[2] 'Arch. f. Naturges.,' Bd. x, p. 103, 1845.
[3] Kröyer's 'Nat. Tids.,' Rœk. 2, Bd. i, p. 413, pl. ii, fig. 10, 1844.
[4] 'Du Bois Reymond's Archiv,' 1867, Taf. 13, fig. 7.
[5] 'Beobacht. Anat. u. Entwickel. Seeth.,' p. 65.

organs" are the source of the generative products, and are, in short, the organs of reproduction.

Claparède[1] (1863) gives an account of a young Spionid of about eighteen bristled segments, and somewhat resembling *Polydora*, but differing in various respects, such as in pigment-specks, more numerous branchiæ at the same stage, and bifid crenated anal region. It differs from *Prionospio* in the origin of the branchiæ, which in that form arise on the thirteenth segment, whereas in Claparède's they begin on the seventh bristled segment. It may be the young of *Nerine* or *Polydora*.

In *Malacoceros Girardi*, De Quatrefages (1850) described small paired cephalic ganglia, œsophageal connectives, and a double ganglionic chain, the ganglia, however, being slightly marked. A ganglion, moreover, exists at the origin of the visceral nerves from the connectives. The arrangement of the nervous system of *Aonis foliacea* is similar, though in the figure the anterior ganglia are fused. He (1850) denies that the tentacles of the Spionidæ are respiratory, but as they contain cœlomic fluid in their interior they may be indirectly so. He thinks a true branchia has an afferent and an efferent vessel, or a single vessel with lacunæ hollowed out in the enveloping tissues.

The same author, somewhat later (1865), separated this group into two families, one of which, the Neriniens, he regarded as errant, and the other, the Leucodoriens, he placed amongst the sedentary forms. This arrangement has little to support it, and much weight against it; indeed, it serves only to confuse the observer. It is true he speaks of the uncertainties and contradictions in the literature of the subject, but such a method as he adopted was not calculated to promote perspicuity. He arranged the Neriniens according to the structure of the feet, the biramous types being deprived of cirri in *Nerine*, which had no crotchets, whilst *Uncinia* had; whereas *Aonia* bore inferior cirri only, and *Malacoceros* and *Colobranchus* both dorsal and ventral cirri, the former being devoid of eyes, the latter with them. *Pygospio* had a uniramous foot. The Leucodoriens were placed after the Ariciidæ and other sedentary forms. The genera were discriminated by the structure of the feet, which in some are divergent and biramous, and the branchiæ superior. In *Leucodore* the branchiæ are inferior; and the third segment is abnormal in *Disoma*; but in *Polydora* it is the fifth or sixth segment which is abnormal. Uniramous feet, again, occur in *Spione*, while in *Spiophanes* the feet are uniform throughout.

In his 'Structure des Annélides sédentaires,' Claparède[2] (1873—a posthumous volume) gives many interesting features relating to the Spionidæ. Thus, in *Audouinia filigera*, the cuticle, which is thin in sedentary Annelids, and the hypoderm, are pierced by pores and canals for transmitting the secretion of the subjacent follicles. In *Nerine cirratulus* the hypoderm is thick on the ventral surface, indeed, he distinguished a superficial fibrillar hypoderm and a deeper stellar connective-tissue layer. The Spionidæ have bacilliparous glands. In *Audouinia* the longitudinal muscles lie between the fibres of the circular coat. The last mentioned is very thin on the branchiæ and tentacles. In the figure the muscle is outside the hypoderm, a position the author would at once have corrected. The cœlomic epithelium enters the tentacles as well as covers the dissepiments which cease

[1] 'Beobacht. Anat. Entwickel.,' p. 72, Taf. viii, figs. 4—6.

[2] 'Annel. Sedent.,' pl. xi, fig. 5.

near the œsophagus. In *Nerine* and other Spionids the branchiæ have a single line of cilia.

The middle region of the body in *Audouinia* presents in section a ventral vessel, and the dorsal is very large and contains a brown central mass. The two lateral vessels are also large. The dorsal is surrounded by a sinus with a superior and inferior branch, with which it is in direct communication. A transverse branch on each side passes to the longitudinal lateral, from which branches go to the branchiæ. The blood is conveyed from the branchiæ by a transverse trunk to the ventral vessel, and furnishes a rich series of capillaries to the feet. The dorsal ends anteriorly in two large vessels supplying the branchiæ and tentacles. A heart-body is present. The branchiæ have both artery and vein; the tentacles only a single vessel.

In *Andouinia filigera* the nerve-cords are within and in contact with the circular muscular coat. The cerebral ganglia are absent, and the two œsophagus connections diminish rapidly in front. Each branchia in this form has two nerves, and so with the tentacles. In *Nerine cirratulus* the nerve-cords are separate, and the single "tubular fibre" lies between them, and passes below the transverse commissure.

The Spionidæ constituted the first and most typical family in Levinsen's[1] (1883) Syllidiformia Spionina, but the divergent families which followed showed how difficult it is to form large natural groups of the Polychæta. He placed *Nerine*, *Scolecolepis*, and *Aonides* under the genus *Spio*. He grouped the genera as follows: *Prionospio*, *Spiophanes*, *Polydora*, *Spio*, *Disoma*, and *Aonides*—*Pœcilochætus* being appended.

Benham[2] (1896) considered that in the "Spioniformia" neither tentacles nor palps are present, but that the peristomium carried two long tentacular cirri, and extended forward at the side of the prostomium. He grouped under this sub-order the families Spionidæ, Polydoridæ, Chætopteridæ, Magelonidæ, and Ammocharidæ. It is doubtful if much can be gained by this association of the third and fifth families with the other three. The sub-order fell under the branch Phaneorcephala "in which the prostomium retains its ancestral condition as a lobe overhanging the mouth."

Leschke[3] (1902) gave an account of the pelagic larvæ of *Polydora ciliata*, *Spio seticornis*, and *Nerine* from the Bay of Kiel, accompanied by good figures.

De St. Joseph (1894) describes and figures several larvæ of *Nerine*. The earliest stage resembles that figured by Claparède[4] and Fewkes[5] and has six or seven segments of the body, and was several times found in the cup of a *Campanularia*. In the next stage the head is better developed, tentacles are present, and the four eyes form a transverse row on the head. The first body-segment has a long tuft of bristles on each side. The following stage has seventeen segments of the body, but the long provisional bristles in front are absent. There is no certainty that all belong to the same species.

Hæcker[6] (1896) mentions a metatrochophore of a *Spio* from Naples with six pairs

[1] 'Vidensk. Meddel. Foren. Kjöbenh.,' 1883, p. 180.
[2] 'Polychæta, Camb. Nat. Hist.,' vol. ii, p. 303, *et seq.*
[3] 'Wissenschaft. Meeresuntersuch.,' Bd. v, p. 113, Taf. vi, figs. 1—10.
[4] 'Beobacht. Thiere Normandie,' pl. viii, figs. 4 and 5.
[5] 'Bull. Mus. Comp. Zool.,' t. xii, pl. ii, fig. 2.
[6] 'Zeitschr. f. wiss. Zool.,' Bd. lxii, pp. 89—91.

of long swimming-bristles, paratroch, and telotroch. He also describes and figures a *Nerine* larva, and a stage of *Magelona*. His youngest larva of the Spionidæ is furnished with a pair of provisional bristles. He gives an elaborate scheme of the pigment-specks on the head and body of this group.

Mesnil[1] (1896) in his important treatise on this family observes that in each setigerous lobe the bristles are in two rows—anterior and posterior—and he points out that the other Spionidæ differ from *Spio* and *Scolecolepis* in various characters, such as (1) the disappearance of the branchiæ—

(*a*) From the first setigerous segment.

(*b*) From a certain number of the anterior segments.

(*c*) From a great number of the posterior segments. The latter (*c*) may exist along with *a* and *b*.

(2) A cup-shaped expansion round the anus formed (he says) by the coalescence of the anal cirri.

(3) After a certain segment the posterior row of dorsal bristles includes winged hooks like those in the ventral division.

(4) The anterior ventral row of capillary bristles remains as well as the winged hooks. Sometimes the same occurs in regard to the inferior ventral bristles.

Mesnil also notes that besides *Scolecolepis* there are a few other Spionids in which the prostomium presents two frontal horns. Thus the species which Wirén reported as *Nerine vulgaris*, Johnston, and *Scolecolepis* sp., Marenzeller, present modifications 1 *a* and 3 "on ne suit rien sur les appendices anaux." They constitute Mesnil's new genus *Marenzelleria*.

He gives the following key :

I. Prostomium without frontal processes.

Fifth setigerous segment modified	Branchiæ after the fifth setigerous segment	Polydora.
	Branchiæ on the second setigerous segment	Boccardia.
Branchiæ on first setigerous segment	Vanishing on the first region of the body .	Laonice.
	Continuing to the posterior end . .	Spio.
Branchiæ on second setigerous segment	No winged hooks on dorsal division — Anal cirri . . .	Microspio.
	No winged hooks on dorsal division — Anal region cup-shaped . . .	Nerinides.
	Winged hooks in dorsal division — Anal cirri . . .	Aonides.
	Winged hooks in dorsal division — Anal cup . . .	Nerine.
Branchiæ after second setigerous segment	Dorsal lamella independent of branchia .	Spionides.
	Dorsal lamella soldered to branchia . .	Pygospio.

II. Prostomium with frontal processes.

Branchiæ on first setigerous segment	No winged hooks in dorsal division . .	Scolecolepis.
	Winged hooks in dorsal division . .	Marenzelleria.

The author makes many interesting observations on the morphology of the Spionids. Thus the feet have a dorsal and a ventral lamella behind the setigerous process, and besides the dorsal and ventral bristles some have a small fascicle more ventrally situated. The youngest bristles are in the dorsal situated ventrally, and in the ventral dorsally. The

[1] 'Bull. Sc. France et Belg.,' t. xxix, pp. 110—287, pls. vii—xv, 1896.

anterior and posterior dorsal bristles are generally capillary, and the anterior shorter and larger than the posterior and often punctated. These bristles become very fine posteriorly and in certain genera (*e. g.* *Pygospio* and *Polydora*) disappear more or less completely. The posterior dorsal bristles in *Marenzelleria*, *Nerine*, and *Aonides* are winged hooks, and in *Magelona* the same occurs after the tenth. The anterior ventral are shorter than the posterior, large and generally punctated. The inferior ventral are generally winged and often punctated. The bristles may be shed and renewed, hence various differences. The bundles of fine bristles enclosed in the tissues he and Giard consider defensive, and may be ejected. Mesnil compares these with the bacilliporous corpuscles in *Polydora flava*. As a rule the Spionids have no extrusible pharynx except in *Magelona*, but this statement seems to need revision. The blood-vascular system is well-developed, but contains no corpuscles except in *Magelona*. In each segment a vascular ring connects the dorsal and ventral trunks. These branches send vessels to the branchiæ. Except in *Magelona* a single blood-vessel only occurs in the tentacles. The branchiæ are always simple and richly ciliated, and a dorsal ciliated band connects them across the body, and this is specially developed in *Spiophanes* where no branchiæ are present.

The larvæ of Spionids are widely distributed throughout the ocean, and numerous forms were found in the "Plankton Expedition" and described by Häcker[1] (1898). Some of these so closely resemble the larvæ of British species that they probably belong to the same genera, *e. g.* the *Polydora* larvæ. So far as can be judged the authors' *Chætosphæra* larvæ do not belong to ordinary Spionids, but in Fig. D somewhat approach *Pæcilochætus*.

In the Spionidæ, Goodrich[2] (1900) notes that the nephridia open internally, and that the genital funnel becomes connected with the nephrostome and loses its primitive opening to the exterior.

Salensky[3] (1908) has made important observations on the structure and development of the pharyngeal pouches of *Polydora* and *Scolecolepis fuliginosus*. In the former they are two in number, the anterior passing directly forward from the mouth, the posterior sloping obliquely forward and outward at its sides. In *Scolecolepis fuliginosus* these pouches likewise occur in similar positions, though somewhat modified. The author compares these with what he found in *Polygordius* and *Saccocirrus*, and comes to the conclusion that these fissures or pouches are indications of the gill-clefts in the Chordata and Enteropneusta.

Viguier[4] (1910) described an interesting case of precocious maturity in larval Spionids (*Nectosoma*), 1·6 to 1·8 mm. in length, in which both males and females occurred. He thinks they are apparently larvæ of a sedentary form which has become pædogenetic and pelagic. Viguier's larvæ somewhat resemble Graveley's (Plate XIV, fig. 5), and the males have eight segments besides the head and the pygidium, the females a segment

[1] 'Plankton Exped.,' p. 17, Taf. ii, figs. 14—18, text-fig. B, and *Chætosphæra*, figs. C and D.

[2] 'Quart. Journ. Micr. Sci.,' vol. xliii, N.S., p. 740.

[3] 'Bull. Acad. Imp. Sc. St. Pétersburg,' p. 687, with 23 text-figures.

[4] 'Compt. Rend. Acad. Sc.,' cli, pp. 104—6; and also (1911) 'Ann. Sc. nat.,' 9e sér., t. xiii, p. 235, pl. viii, figs. 13—17, and pl. ix, figs. 23—30.

more. The head was devoid of tentacles, and had four touches of pigment disposed in a trapezium and without lenses, whilst each segment had a yellowish-brown stellate pigment-speck. They may be compared with the form alluded to on p. 152.

The cilia in the Spionids generally occur in two rows on the dorsum, between the branchiæ, which also bear a conspicuous one, though in some cases only a single row occurs on the dorsum (Lubischew).[1]

R. Leuckart describes and figures a larval Spionid with a pointed snout and the provisional spiny bristles, from Nice and Villafranca, and in which the alimentary canal is pinnate throughout the greater part of its length, as in *Pœcilochætus*. The snout resembles that of *Nerine cirratulus*.

The pelagic larvæ (Plate XCIV, figs. 8—11 and 14) pertaining to this family (*e. g.* *Polydora*) occur in the tow-nets from January onward, though they are fewer in that month than in February. *Nerine* appears about the same time, and swarms in April. Young *Magelona* occurs in May and also in June, July, and August, when larvæ of Spionids are very abundant. Such forms as *Magelona* appear to have passed their larval stages and to have entered the later stages before they take up their residence on the bottom, since they still are captured in the nets in August. The bottom-nets in September teemed with numerous Spionids, amongst which were the young of *Magelona* with the papillæ well-developed on the tentacles; whilst in the surface-nets of the first half of October they still were present, though in limited numbers, and the same may be said of November.

Reproduction of lost parts readily takes place in the Spionidæ, the facility with which many rupture their bodies being thus compensated by readiness in reproduction. Amongst others, Bobretzky[2] observed reproduction of the anterior region in *Spio lævicornis*, and Jacobi[3] in *Polydora quadrilobata*. Mesnil[4] also records the same in *Polydora Giardi*, *P. armata*, *Nerine cirratulus*, and *Pygospio elegans*. Nusbaum[5] and Ivanow observed this feature in *Nerine cirratulus*, whilst Giard[6] found that larvæ of *Polydora* regenerated either end.

Spionids frequent clean sand along the margin of low water and some distance shorewards, as well as range to deep water, even the common *Nerine foliosa* descending to a depth of 725 fathoms. Many form protective tubes of secretion and sand, whilst others, like *Polydora*, penetrate shells and rocks of various kinds, and in regard to wide distribution and the general effects of rock and shell erosion the family is one of the most conspicuous. Their colours are often bright, browns, greens, and yellows predominate, whilst in many the crimson vessels in the branchiæ enliven the other shades. Their distribution is wide, but many are confined to shallow water. Thus, in the 'Challenger,' only the genera *Scolicolepis* (*S. cirrata*) and *Prionospio* occurred.

[1] 'Mitt. Zool. Stat. Neap.,' Bd. xx, p. 348, 1912.
[2] 'Mém. Soc. de Natural. de Kiew,' t. i, 1870.
[3] 'Inaug. Dissert.,' Taf. ii, 1883.
[4] 'Bull. Sc. Fr. et Belg.,' t. xxix, pl. vii—xv, 1896.
[5] 'Zeitschr. f. wiss. Zool.,' Bd. lxxix, Taf. xiii—xvi, 1905.
[6] 'C. R. Assoc. Française,' 1901, pt. 1, p. 153.

Genus XCVI.—Nerine, *Johnston*, 1838.

Nerine, Johnston; *Aonis*, Audouin and Edwards; (*non* Savigny); *Spio*, Johnston, Rathke; *Lumbricus*, Delle Chiaje; *Malacoceros*, De Quatrefages.

Snout (prostomium) with a rounded or acute point; mouth with a massive proboscis. Branchiæ from the second setigerous segment almost to the posterior extremity. Cup-like anal structure. Integuments with bacilliparus follicles. Membranous lamella along the branchiæ, at least in the anterior segments, with capillary bristles only; row of cilia on both bases of the branchiæ. Feet biramous. Ventral lamella elongated transversely after the thirtieth or fortieth setigerous segments, presenting a median inflection, then a ventral lobe. Winged hooks both dorsally and ventrally, but in some they are absent from the anterior rows. Eggs have a zona (chorion, Mesnil) with minute transparent vesicles. All the species are of some size. Feed on Fuci and minute shells.

In *Nerine foliosa* the pointed snout is completed by the intricate interlacing of the muscular fibres beneath specially thickened cuticular and hypodermic layers. As soon as the body-wall assumes a rounded form a layer of circular and oblique muscular fibres occurs beneath the hypoderm, the majority having an oblique direction. The appearance of the mouth, by the infolding of the muscular lip, alters the outline inferiorly, the massive sides being fixed by muscular bands to the dorsal arch superiorly, whilst the lateral area on each side is occupied by oblique and transverse fibres and numerous ramified blood-vessels. Strong transverse bands of muscular fibres occur in the lower lip, and grasp the various ridges on the inner surface of the canal. These fibres turn upward at each side, and mingle with those of the upper lateral region, and some pass to the dorsal wall. They thus constrict the aperture efficiently. A little behind the foregoing the œsophagus is suspended in the centre of the area by strong muscular bundles, the most conspicuous of which are vertical, passing from the basement layer beneath the hypoderm dorsally to the œsophageal wall. A second series of fibres, as they descend to their insertion at the ventral surface, give lateral support to the tube, whilst a third group of fibres interlace in a complex manner, and with the blood-vessels, as in front, fill up the space between the œsophagus and the body-wall.

Toward the posterior part of the head a slight hypodermic prominence indicates the position of the cephalic ganglia which lie outside the muscular layers. In a line with the first bristles the circular muscular coat is better defined, though in the dorsal region the fibres spread out at each side and mix with those of the vertical, a comparatively thin layer crossing the middle line of the dorsum. Within the circular muscular coat dorsally is a more or less developed longitudinal ventral layer—at first less definitely arranged, but by-and-by grouped in three bands, viz. first, a thin median sheet between the wide attachment of the vertical muscles, and a more powerful band stretching between the outer margin of the vertical and the foot, and as the fibres of the oblique pass outward and upward to the foot this section of the muscle is thus clasped in a special chamber in various sections. The dorsal longitudinal muscles are already normal in position and arrangement, the broader end of the muscle in section being external, the narrower

internal. The hypodermic elevation in the mid-dorsal line forms a prominent ridge, but it soon disappears. The alimentary canal with a deep involution dorsally fills up the central region, and is slung by strong fibres from the mid-dorsal line. The nerve-cords are widely separated, somewhat elliptical in section, and lie in the hypoderm below the attachment of the oblique muscle on each side to the basement-layer, a pale area occurring between them. They have thus gradually descended from the lateral region.

In this region a notable feature is the lateral position of the ventral longitudinal muscles, for they are separated in the mid-ventral line by the extended inferior attachment of the oblique, and by a small central group of longitudinal fibres above them. The circular muscular coat passes externally from side to side under the basement-membrane, and a strong band of the vertical muscle lies likewise at their inner border, whilst other bands traverse the ventral longitudinal muscles. The great extent of the ventral outline is thus accompanied by changes in the arrangement of the body-wall.

As soon as the body assumes a transversely elongated form the dorsal longitudinal muscles are extended, and are, besides, intersected by the powerful vertical bands which pass from the dorsal basement-layer to the ventral surface—through the ventral longitudinal muscles. The oblique muscle on each side is more horizontal, extending from the inferior bristle-bundle to the median line at the ventral surface, and across, or even through the vertical bands, before insertion. The nerve-cords now lie close together below the transverse muscle (a remnant of the circular), and a distinct neural canal occurs at the inner and upper border of each. A few longitudinal fibres are still present between the ventral attachments of the oblique muscles. Externally the alimentary canal has its cœlomic epithelium, and thin layers of external longitudinal and internal circular, the thick cellular mucous layer resting on a basement-layer. Moreover the canal is diminishing in area.

It is soon apparent, in proceeding backward, that the vertical muscles descending from the dorsal to the ventral surface do not interdigitate with the great longitudinal muscles throughout their entire extent. They leave, as observed by the late M. Claparède, at the external border of each dorsal muscle, a considerable mass, which bends downward, and presents in transverse section a distinctly pinnate appearance, whilst the rest of the muscle on each side is traversed by strong vertical fibres. These vertical fibres which pass downward close to the wall of the alimentary canal are attached on each side of the mid-ventral line (Fig. 113) to the incurved wall over the nerve-trunks. The tips of the now slender oblique muscles still more nearly approach the middle line, which is occupied by the ventral vessel and its branches, very few longitudinal muscular fibres being apparently beneath them. The hypoderm in the mid-ventral line is specially thickened, and the fused nerve-cords have a single large neural canal in the middle, the nerve-area having internally the basement-tissue, circular fibres, and longitudinal fibres and the ventral vessel. The fibres of the oblique muscle enclose the area on each side for the ventral longitudinal muscle, which has both an internal and external incurved process of muscle also distinctly pinnate in section. The rest of this muscle is traversed by strong bands of the vertical muscle. The

alimentary canal in this region is a flattened tube with the dorsal and ventral vessels above and below.

The segmental organ lies to the exterior of the outer pennate fold of the ventral longitudinal muscle.

Behind the foregoing the vertical muscles diminish, and then almost disappear, the dorsal and ventral longitudinal muscles becoming solid layers, the dorsal with its thickest edge on each side of the middle V-shaped internal, the massive internal borders of the ventral being more widely separated, and having between them circular fibres, and above this a band of longitudinal fibres on each side of the ventral vessel, with fibres from the alimentary canal. The hypoderm is thickened over a broad area in the mid-ventral line,

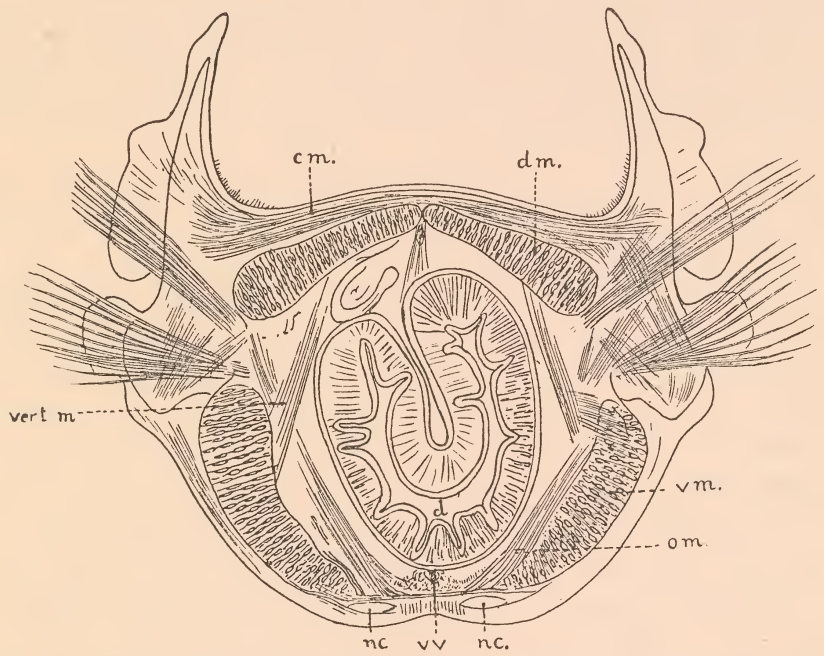

Fig. 113.—Transverse section of the body-wall of the anterior region of *Nerine foliosa*, Sars.
vert. m. Vertical muscular bands.

and the single neural canal is smaller, and situated at the upper part of the nerve-area. The pennate folds of dorsal and ventral longitudinal muscles have disappeared. The alimentary canal has a much thicker layer of longitudinal muscle-fibres externally with a circular coat beneath, and the thick mucous layer has smaller cells.

In *Nerine foliosa* the bright red blood is driven from the tail forward in the dorsal vessel, which sends off in each segment a trunk to the branchiæ, the aerated blood descending by the branch joining the ventral. There is no special provision for thrusting out the proboscis as in *Magelona* since *Nerine* bores with its pointed snout and muscular body.

In *Nerine cirratulas* the nerve-cords, after meeting in the mid-ventral line, are proportionally larger, and the preparations show a distinct neural canal toward the lower part of each. The ventral longitudinal muscles are also more compact anteriorly, whilst the dorsal taper to a thin arch superiorly. The alimentary canal anteriorly has deep folds and ridges of its mucous membrane. In the median line ventrally are a central and

two lateral ridges of hypoderm. The segmental organ appears to have a canal sufficiently large to transmit the sexual elements.

Under the family of the Ariciens Milne Edwards in 1834 placed the genus *Aonis*, Savigny, as adopted by De Blainville, the sole species being *Aonis foliacea* = *Nerine foliosa*. He thought the group approached *Nephthys*, though differing in various respects.

It has been remarked by Sars and Claparède (1868) that if Johnston had been fully acquainted with the genus *Spio* of O. Fabricius he would have hesitated to make the genus *Nerine*, for the sole differential character is the presence of lamellæ on the feet of the latter, whereas in the former such are represented only by a minute lobe or a papilla. There is much in common between them, and comparatively little against their union. However, Claparède follows Sars in relegating to the genus *Spio* those in which the membranous lamella is not soldered to the base of the branchia or disappears entirely. On the other hand, under Nerine are grouped those in which the membranous lobe forms a border to the branchia in the anterior segments.

Claparède further shows that in certain species there is a circle of anal papillæ, in others a small sucker is present, as in *Polydora*, or in some a simple papilla, but such features are of little moment as between *Nerine* and *Spio*.

De St. Joseph (1894) reviews the history of the genus *Nerine*, Johnston, and lays stress on Malmgren's duplication by reviving the genus *Scolelepis* (not *Scolecolepis*, Blainville), created for the *Lumbricus squamatus* of O. F. Müller (*Nerine vulgaris*, Johnston ?). Malmgren joined with this form *Nerine cirrata*, Sars, and *N. oxycephala*, Sars. The author rightly states that these three species differ in the form of the head and other particulars, the only common bonds being the membranous lamella on the branchiæ and the circlet of cirri at the anus. He considers that a new arrangement is necessary. This author describes and figures three stages of the common *Nerine* from the younger of five bristled segments without tentacles to that of seventeen bristled segments with tentacles of same size. These were captured in tow-nets at Dinard, though the adults were not found between tide-marks.

Mesnil (1896) gives an historical review of the genus which was established by Johnston for two divergent species, the first being *Scolecolepis vulgaris*, and the second, he says, pertaining to the genus *Spio*, but the latter is a misapprehension, for the species is the *Nerine foliosa* of Sars. He points out that Œrsted, after Sars, distinguished *Nerine* from *Spio* by the greater or less development of the dorsal lamella, yet Claparède showed that this distinction is artificial, and held that the association of the lamella with the branchiæ almost to their extremity was more appropriate. Mesnil, on the other hand, preferred to rely on the distribution of the winged hooks and the anal differentiation. He included *Malacoceros*, De Quatrefages, and *Aonis*, Audouin and Edwards.

1. Nerine foliosa, *Audouin and Edwards*, 1833. Plate XC, fig. 1; Plate XCVI, fig. 13 —anterior end; Plate XCVII, figs. 1—1 *c*—feet; Plate CII, figs. 7—7 *c*—bristles and hook.

Specific Characters.—Head forming a somewhat blunt cone, the dorsal ridge termi-

nating posteriorly in a rounded enlargement followed by a short tentacle. Eyes generally present. Body 6—8 inches in length, and nearly $\frac{3}{8}$ inch broad, somewhat flattened dorsally and slightly convex ventrally, little tapered in front, but gradually diminishing posteriorly to a stellate anus. Segments about two hundred. Colour pale orange or dull yellow anteriorly, posteriorly dull yellow with, in some, a tinge of green. Dorsum marked anteriorly by fine transverse lines. Under-surface dull yellow with a median streak. Branchiæ bright red, but anteriorly the fusion of the superior lamella obscures them.

Feet with branchiæ from the second backward, and amalgamated with the large superior lamellæ from the second to beyond the fiftieth. Interlamellar notch distinct. Ventral lamella, at first prominent and rounded, becomes narrower and elongated from above downward on the appearance of the winged hooks at the fifty-eighth segment. The winged hooks appear in the superior division after the seventieth bristled foot (sixty-fifth, Mesnil). Bristles of the upper division in front form two groups, a long upper series, and a shorter inferior—all curved, dappled, and finely tapered.

Synonyms.

1806. *Lumbricus squamatus,* Abildgaard. Zool. Danica, vol. iv, p. 39, Tab. clv, figs. 1—5.
1828. *Spio viridis,* Johnston. Zool. Journ., vol. iii, p. 486.
1833. *Aonis foliosa,* Audouin and Edwards. Ann. Sc. nat., t. xxix, p. 400, pl. xviii, figs. 9—13.
1834. „ „ idem. Hist. nat. Litt. Fr., t. ii (Annélides), p. 263, Tab. vi*a*, figs. 9—13.
1838. *Nerine coniocephala,* Johnston. Mag. Zool. and Bot., vol. ii, p. 70, Tab. ii, figs. 9—13.
1843. „ „ and *Aonis foliacea,* De Quatrefages. Mag. de Zool., sér. 2, An. 5, p. 14, pl. ii, figs. 9 and 10.
1850. „ „ idem. Ann. Sc. nat., sér. 3e, t. xiv, p. 360, pl. x, fig. 2.
1851. *Nerine foliosa,* Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 207.
„ „ *coniocephala,* Grube. Fam. Annel., pp. 66 and 134.
1853. *Spio coniocephalus,* Sars. Nyt Mag. f. Naturvid., Bd. vii, p. 381.
„ *Nerine foliosa,* idem. Ibid., Bd. vii, p. 381.
„ „ *foliata,* Dalyell. Powers Creator, vol. ii, p. 155, pl. xx, figs. 11—18.
1855. *Aonis vittata,* Grube. Archiv f. Naturges., Bd. xxi, p. 110.
1861. *Nerine foliosa,* Sars. Reise, 1849, p. 207.
„ „ „ Danielssen. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 52.
„ „ „ Sars. Förhandl. Vidensk.-Selsk. Christ., p. 61.
1864. *Aonis foliosa,* Kölliker. Kurzer Bericht, pp. 9 and 14.
1865. *Nerine coniocephala,* Johnston. Cat. Worms Brit. Mus., p. 201, Tab. xvii. figs. 9—13.
„ *Aonis vittala,* idem. Ibid., p. 343.
„ *Nerine coniocephala,* Carrington. Annel. Southport, p. 8.
„ „ „ De Quatrefages. Annel. i, p. 438.
„ *Aonis foliacea,* idem. Ibid., p. 441, pl. xviii, f. 2—4.
„ „ *foliosa,* idem. Ibid., p. 663.
1867. *Nerine* „ Malmgren. Annul. Polych., p. 89, Tab. ix, fig. 53.
1869. „ „ Grube. Mittheil. St. Vaast, p. 37.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 126.
„ „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 24.
1879. „ „ Tauber. Annul. Danica, p. 115.

1883. *Spio foliosus*, Levinsen. Vidensk. Meddel. Foren. Kjöbenh., p. 99.
1888. *Nerine coniocephala*, Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 636, pl. xxxvi, fig. 1.
„ „ „ Cunningham. Quart. Journ. Micr. Sci., vol. xxviii, N.S., pp. 248 and 273, pl. xviii, fig. 9.
1894. *Spio foliosus*, Bidenkap. Christ. Vidensk.-Selsk. Förhandl., p. 95.
„ *Nerine foliosa*, De St. Joseph. Ann. Sc. nat., 8e sér., t. xviii, p. 72, pl. iv, figs. 84—85.
1896. „ „ Mesnil. Bull. Sc. Fr. Belg., sér. 4, t. xxix, p. 165, pl. x, figs. 13—18.
1897. *Scolecolepis foliosa*, Michaelsen. Polych. deutsch. Meere, p. 152.
1904. *Nerine coniocephala*, Journ. M. B. A., vol. vii, p. 227.
1909. „ *foliosa*, McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 156.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, No. 47, p. 100.

Habitat.—Abundant in sand and muddy sand between tide-marks, and tossed on the beach after storms. Generally distributed around the British shores.

Elsewhere it is found in the North Sea, Norway, Sweden, Finmark (Malmgren), and France, and ranges to a depth of 1,326 mètres ('Porcupine').

Anteriorly the body is pale orange or dull yellow, posteriorly dull yellow with, in some, a tinge of green. The dorsum is marked anteriorly by fine transverse lines, darker in some than in others. The under-surface is dull yellow with a median streak. The branchiæ are bright red, but from the yellow border in those arising anteriorly this is somewhat obscured. This yellow crest degenerates posteriorly into a light orange pad to the outer side of the branchial process. In some examples from Plymouth a deep orange hue characterised the anterior bristles.

In the anterior region of the body, where both fillets are present in the feet, and where the branchiæ are large, each segment dorsally shows two transverse ridges and a median furrow, whereas ventrally the segment is undivided, each being separated by a deep furrow at the junction in front and behind. In the next region, where the branchiæ are less, the dorsum of each segment has an elevated transverse ridge with a narrow groove and a belt in front and behind. Ventrally, a broad ridge with a furrow, and a narrower belt in front and behind occurs. Still further backward, and where the branchia is represented by a rounded papilla, the dorsum shows an elevated transverse band with a more or less median furrow, an enlargement in the centre of the dorsum anteriorly, and one at each side, the intermediate region being marked by transverse lines. On the ventral surface a similar elevated transverse band is present, but the lateral enlargements are indistinct, and though there is an interrupted median band no median enlargement of the transverse band is visible.

Head (Plate XCVI, fig. 13) forming a somewhat blunt cone (rounded button, Mesnil), the dorsal ridge terminating posteriorly in a rounded enlargement followed by a short tentacle. Eyes, four, placed at the base of the tentacle. (No eyes, Mesnil.) Tentacles (palpi, Mesnil) elongate, tapering. Proboscis forming a short cylinder in extrusion, the free margin presenting an irregular series of frills, whilst the column is marked by longitudinal grooves ventrally. In some in full extrusion two pouting lobes occur distally (Plate XCVI, fig. 13), with a smaller bilobed process above and a single lobe below, whilst within the frilled margin laterally and inferiorly is a crenate brown line indicating a differentiation. The body reaches 6—8 inches in length, and in large examples is

The nephridia occur in the posterior region, and are described by Cunningham and Ramage as spherical in shape, with short internal and external ducts.

Reproduction.—Ova abound in examples towards the end of June and in July at St. Andrews.

Little change, to judge from Claparède and Mecznikow's larvæ of *Audouinia filigera*,[1] occurs in the development of this form from the length of 1·3 mm. onwards.

Alex. Agassiz (1866) clearly distinguished between the young of *Nerine* and that of *Polydora*, and traced the growth of a *Nerine* which he linked to *Nerine foliosa* (his *N. coniocephala*). His youngest stage had seven bristled segments, besides the bunch of temporary bristles in front, which, as the author states, "spread fan-like in every direction, and the animals roll themselves up in a ball like a hedgehog, and become quite motionless, but soon start off again on their rapid gyrations, performed by means of an exceedingly powerful circle of vibratile cilia surrounding the head," and perhaps aided by those on the tail. The body-segments have indications of dorsal cirri, with two tufts of bristles, the one serrated, file-like, the other smooth capillary forms. Six eye-like pigment-specks occur on the head, the outer posterior on each side soon disappearing. The later stages chiefly differ in the elongation of the body, the disappearance of the temporary bristles, the occurrence of stiff hook-shaped bristles, the presence of rows of short cilia on the segments dorsally and ventrally (younger stages), the increase of the dorsal cirri, and the elongation of the tentacles. The alimentary canal is differentiated into gullet, stomach and intestine. He points out that the serrated bristles are not lost, but form a long tuft on the posterior side of the dorsal cirri. He thought Claparède was warranted in associating the group (*Nerine*, *Spio* and *Polydora*) with the Ariciæ, and that the earlier stages of *Nerine* resembled Busch's larva.[2] It is curious that in certain fossil annelids bunches or single bristles—all large and rough—occur, and appear out of proportion to the width of the body.

Habits.—It is strictly a dweller in wet sand through which it evidently burrows with ease, the powerful and prominent hooks posteriorly enabling it to cling firmly to its tunnel. Though dug out almost entire it soon abbreviates itself, either in sea-water or in a vasculum amidst seaweeds. The tentacles are often thrown off when immersed in spirit. The thrusting out of the proboscis is less complex than in *Magelona*, for *Nerine* bores in the sand with its pointed snout and muscular body. It gulps water by the mouth. It is neutral to test-paper.

A curious specimen comes from the West Sands, St. Andrews, March 26th, 1898, in which the branchiæ form simple subulate filaments along the dorsum, and the setigerous processes for the dorsal bristles are rounded and almost conical. The specimen is much softened, and the changes may have been partly due to maceration. The bristles and hooks resemble those of *Nerine foliosa*.

So far as can be ascertained, the *Lumbricus squamatus* of Abildgaard (1806) comes nearest to this species both in description and figures—if by "squamis" lamellæ are meant, and the figures bear this out. The colours, structure and habits agree.

The *Spio lævicornis* of H. Rathke[3] (1837) seems to be a closely allied form.

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xix, p. 193, Taf. xii, fig. 5.

[2] 'Beobachtungen,' pl. viii, fig. 1—2.

[3] 'Fauna der Krym,' p. 421, Tab. viii, fig. 1—6.

After the fiftieth foot[1] a change takes place in the nature of the bristles. The bristles of the upper division remain for the most part similar to those in front, though the row is longer, but those of the ventral row, with the exception of a few inferiorly, have assumed the form of the hooks characteristic of the posterior region, viz. stout shafts deeply inserted in the tissues, a stout distal part slightly tapered and ending in a blunt tip, on each side of which is a wing (Plate CII, fig. 7 *b* and 7 *c*).

At the seventieth foot the branchia has lost much of its external membranous frill, and is again separated inferiorly from the posterior fillet of the upper division of the foot which rises into a prominent border superiorly. The anterior fillet has disappeared in both divisions, and the fillet from the second ring of the segment runs up behind the posterior fillet at its ventral edge. The bristles in the upper division remain simple, but are more slender. Those of the inferior division consist of winged hooks, with the exception of a few superiorly and inferiorly.

At the ninetieth foot (Plate XCVII, fig. 1 *b*) the branchia has still further diminished, the upper (posterior) fillet is prominent, the lower ends in a free peak superiorly and inferiorly, and the rows of bristles are shorter. The superior division still shows the tapering bristles, but amongst them are a number of the winged hooks. The notch between the divisions is deep, and the lower has only a few of the slender tapering bristles superiorly and inferiorly, a short row of powerful hooks projecting between them toward the lower part of the division.

The chief changes toward the posterior end are the diminution of the branchia, which at the one hundred and twenty-fifth foot (Plate XCVII, fig. 1 *c*) forms a process which is not equal to the vertical diameter of the upper fillet, the decrease in the number of the superior bristles which are in a single fascicle, the abbreviation of the upper border of the long fillet of the ventral division, and the increase and prominence of that part of the fillet bearing the bristles and hooks. The hooks are the chief feature—both dorsally and ventrally—forming a short row in the upper and a long row in the lower division. They are of great strength, have a slight curvature at the diminished tip, and a wing at each side. The tip appears to be broken in many, so that slight complexity exists at the end of the forward curve distally. The bristles occur above and below each row of hooks, are few in number, and have the same form as in front.

Still further backward the branchia has shrunk to a minute rounded papilla, the upper fillet is short and almost semi-circular, bearing very long hooks and a long slender bristle or two above and below, whilst a broad gap separates it from the inferior fillet, which, though diminished, resembles that in front, viz. has a more prominent margin at the lower half which bears the hooks, with a bristle or two toward the upper and lower margins of the row. The lower margin of the fillet is more prominent than the upper.

The circulation is less intricate than in *Magelona*. The bright-red blood is driven forward from the tail in the dorsal vessel, and sends off a branch in each segment to the branchia, which, after aëration, passes its blood into the trunk joining the ventral. At the tail a kind of caudal reservoir is formed at the junction of the trunks.

[1] Mesnil says the hooks appear ventrally on the fifty-eighth segment and dorsally on the sixty-fifth. He gives the number as twenty ventral and twelve dorsal. In the early rows of hooks the anterior range of bristles persists, but they by-and-by disappear.

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Some confusion seems to have crept into Dr. Johnston's (1865) description and figures, for part of his description of *Nerine coniocephala* would apply to *Nerine cirratulus*, Delle Chiaje, whilst his figure indicates *N. foliosa*.

Mesnil (1896) does not feel certain that the species described as *N. coniocephala* by Cunningham is *N. foliosa*. It has four eyes. He would refer Johnston's species to the genus *Spio*, but this change is a doubtful one.

2. Nerine cirratulus, *Delle Chiaje*, 1829. Plate XC, fig. 2; Plate XCI, fig. 4; Plate XCVII, figs. 2—2 *c*—feet; Plate XCVIII, fig. 1—head; Plate XCIV, figs. 4—6 and 12—ova and larvæ; Plate CV, figs. 1—1 *d*—bristles and hook.

Specific Characters.—Head acutely pointed anteriorly, the central process passing backward to end in the median tentacle. Median ridge supported by the buccal segment on each side, so that the snout appears to be trilobed. Eyes four, small, the anterior pair wider apart, situated in front of the occipital tentacle. Body 6—8 in. in length and possessing about 200 segments, tapering a little anteriorly and much more so posteriorly where it ends in a crenate anus (semicircular, bilobed membranous process under which opens the anus, Claparède and Lo Bianco). General colour greenish, deepest in front with the exception of the snout which is pale or pinkish. The Mediterranean forms are said to be rose-red (Carus). Feet with the branchiæ from the second backward. The dorsal lamella is attached to the outer edge of the branchiæ in front and at first has two divisions (*e. g.* from the tenth to the twenty-fifth), then it becomes single and hatchet-shaped and is fixed only to the base of the branchia. Bristles of this division dappled, with a long and finely tapered upper series and a shorter lower series, mostly with traces of wings. Ventral lamella deep and prominent in front, then it increases in vertical length, becomes narrower and is in three divisions, an upper with a free lobe at first, a middle, and a ventral conical portion. Winged hooks appear in the ventral division about the forty-fifth (Mesnil says thirty-eighth to forty-third), and in the upper division about the eightieth (Mesnil forty-eighth to fiftieth). The winged hooks have a small, blunt fang with a spike on the crown above.

Synonyms.

1789. *Lumbricus squamatus*, O. F. Müller. Zool. Danica, Bd. iii, p. 39, Taf. clv, fig. 1—5.
1829. „ *cirratulus*, Delle Chiaje. Memorie, vol. iv, p. 177, Tav. 64, fig. 16.
1841. „ „ idem. Descrizione, pl. 166, fig. 16, and iii, p. 84, and v, p. 99.
1843. *Malacoceros longirostris*, De Quatrefages. Mag. de Zool. (2) An. 5, p. 8, pl. iii, figs. 7 and 8.
1853. *Nereis foliata*, Dalyell. Powers Creat., i, p. 155, pl. xx, figs. 11—18.
1865. *Malacoceros longirostris*, De Quatrefages. Annel. i, p. 444.
1868. *Nerine cirratulus*, Claparède and Mecznikow. Zeitschr. f. wiss. Zool., xix, p. 163 (young).
„ „ „ idem. Ann. Nap., p. 326, pl. xxiv, fig. 1.
1870. „ „ idem. Annel. Sedent., pp. 15, 24, 53, 64, 70, 71, 100, 102, 107, 120, pl. xv.
1873. „ *agilis*, Verrill. U.S. Comm. Fish., i, 1873, p. 346 and 600.
1879. „ *heteropoda*, Webster. Trans. Albany Inst., ix, pl. viii, fig. 103—110.
1884–5. „ *cirratulus*, Carus. Fauna Medit., p. 256.
1888. „ „ Cunningham and Ramage. Trans. R. Soc. Edinb., xxxiii, p. 637, pl. xxxvi, fig. 2.
„ „ „ Cunningham. Quart. Journ. Micr. Sc., vol. xxviii, N.S., p. 246, pl. xviii, fig. 7—9.

1889–90. *Scolecolepis vulgaris,* Malaquin. Rev. Biol. Nord Fr., t. ii, p. 185.
1890. „ „ Giard. Bull. Sc. Fr. et Belg., t. xxii, p. 80.
1891. *Nerine cirratulus,* Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 254.
1893. „ „ Lo Bianco. Atti d. R. Acad. Sc. Napoli, 2 ser., vol. v, No. 11, p. 32.
1894. „ *longirostris,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 74, pl. iv, fig. 86—90.
1896. „ *cirratulus,* Mesnil. Bull. sc. Fr. Belg., t. xxix, p. 152, pl. ix.
1897. *Scolecolepis squamata,* Michaelsen. Polych. deutsch. Meere, p. 45.
1898. „ „ De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 349, pl. xx, fig. 164.
1904. *Nerine cirratulus,* Fauvel. Journ. M. B. A., vol. vii, p. 227.
1905. „ „ Nusbaum. Zeitschr. f. wiss. Zool., Bd. lxxix, p. 22, Taf. xvi, fig. 39.
1909. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 158.
„ „ „ Fauvel. Bull. Inst. Ocean., p. 6.
„ „ „ Lo Bianco. Mitt. Zool. St. Neap., Bd. xix, p. 582.
1910. „ „ Southern. Proc. Roy. Irish Acad., xxvii, p. 234.
„ „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 99.

Habitat.—Found on shore at the East and West Sands, St. Andrews, after storms, and occasionally obtained by digging in the sand at low-water mark (E. and R. McIntosh); Southport Sands (Dr. Carrington and W. C. M.); Firth of Forth (Cunningham and Ramage); Plymouth (Allen); Malahide and Clare Island (Southern).

Abroad it occurs in the Mediterranean (Delle Chiaje, Claparède, Lo Bianco); in fine sand with *Ophelia*, shores of France (De Quatrefages, Mesnil and De St. Joseph); Heligoland (Michaelson).

It abounds on the grounds inhabited by *Arenicola*.

Head (Plate XCVIII, fig. 1) acutely pointed anteriorly, the central processes passing backward to end in the median tentacle, so that when this is flattened, as in many preparations, the snout seems to be pointed at both ends. The occipital tentacle is usually free beyond the base but occasionally is fixed throughout, its broad prominent base being in front, and its tapering tip reaching the second or third bristled segment. The median ridge is supported by a process of the buccal segment at each side, and thus when viewed from the dorsum the region is trilobed. The eyes are situated in front of the occipital tentacle in the form of four small points, the anterior being wider apart, so that the axis passing through the eyes on each side is oblique, sloping from behind forward and outward. The tentacles (palpi of some) (Plate XC, fig. 2) are of great length and often gracefully coiled at the tip. On the ventral surface of each is a groove, and a red blood-vessel occupies the centre of the organ. At the base of the conical snout ventrally is the opening of the mouth, and, when the proboscis is extruded as a frilled button, the aspect of the parts is considerably altered.

The *body* reaches 6—8 in. in length, tapers a little anteriorly, and much more posteriorly. It is concave from side to side anteriorly, but throughout the rest of its extent is slightly convex. Ventrally the surface is more or less convex, with an interrupted and elevated median band. Tapering to the posterior extremity the body ends in a pouting anus, which seems to be slightly crenate. De St. Joseph[1] observes that over the anus is a membranous multilobed flap.

[1] 'Ann. Sc. nat.,' 7e sér., t. xvii, p. 76.

In life the general aspect is greenish, the colour being deepest in front, with the exception of the snout, tentacles, and buccal region, the former being pinkish, the latter pale. The fine red branchiæ, the blood in the dorsal vessel and in the tentacular vessels enliven the outline, though only a single vascular loop is present in each branchia. The tints vary in different specimens, as shown in some segments of a reddish form from St. Andrews (Plate XCI, fig. 4). Mesnil found fragments of *Ulva* and diatoms, particularly *Schizonema*, in the digestive tube.

The first foot, like that of *N. foliosa*, is devoid of a branchia, though the upper lobe from its development superiorly is somewhat lanceolate. It has a group of short, tapering simple bristles with indications of a wing on each side of the tip. The ventral lobe is proportionally more prominent than in *N. foliosa* and forms a rounded lamella with a fan-shaped group of short, tapering bristles.

The second foot shows a well-marked branchia amalgamated with the inner base of the upper lamella, which is now considerably elongated. A deep notch separates the two distally, the blunt tip of the lamella contrasting with the acutely lanceolate tip of the branchia. This division has a longer tuft of the finely tapered bristles, but from the structure of the lamella they project less than those of the inferior division. The afferent and efferent vessels form a loop considerably within the tip of the branchia. The ventral division has a nearly semicircular lobe and a fan-like tuft of the finely tapered bristles which project considerably beyond it. Indications of wings are visible in many of these bristles. This and the previous foot thus differ from those of *Nerine foliosa*.

The branchiæ continue from the second foot backward to the posterior end, forming in front narrow and acuminate processes, with frilled outer edges which curve over the dorsum, then, proceeding backward, the external frill or border gradually decreases and separates so as to form a free flap including only the base of the branchia.

The tenth foot (Plate XCVII, fig. 2) presents dorsally the long, almost filiform branchia, the coil of the included vessel leaving about one-sixth of the length at the tip free. Nearly a third of its outer border is occupied by the upper flap of the division and the free papilla at the tip projects upward in addition. The strong yet finely tapered longer bristles extend obliquely upward considerably beyond the edge of the flap and only traces of wings are present (Plate CV, figs. 1—1 *b*). The tips of the shorter bristles form a regular series nearer the edge of the flap, and the broader and less tapered tips of these show indications of wings. All are minutely dotted, as mentioned by De St. Joseph. The flap of the inferior division forms an irregular semicircle, shorter from above downward than the superior, but projecting further outward. The dotted bristles also constitute two series, viz. a longer group with finely tapered tips, and a shorter series with shorter tips and indications of wings. The upward slope of these bristles is less than in the case of the dorsal.

Little change can be recorded at the twenty-fifth foot (Plate XCVII, fig. 2 *a*) except that the vertical diameter of the inferior lamella or flap has increased and in some a papilla has appeared on its upper edge, whilst its transverse diameter has diminished. Considerable variation would appear to exist in examples from different localities. Thus Mesnil describes the alteration of the ventral lamella as occurring at the twenty-fifth bristled foot, but the change took place behind this in the British forms, and the foot figured by the French author as representing the incipient stage is the thirty-seventh.

De St. Joseph (1894) mentions that the bifid crotchets occur between the thirty-third and the forty-fifth foot according to the size of the specimen. Long cilia clothe the inner edge of the branchia. At the fiftieth foot the branchia is subulate, the lamella of the upper division is hatchet-shaped, with the lanceolate point dorsal. The dorsal bristles are much more slender and elongate, yet form two series as before. The narrow inferior lobe now has a free process superiorly, whilst a depressed straight area beneath gives origin to four winged hooks followed by a bluntly-conical termination of the lamella ventrally. The hooks (Plate CV, figs. 1 *c* and 1 *d*) have toward the end of the shaft a bold upward curve, then the diminished tip bends backward and ends in a small blunt fang with a spike on the crown inferiorly (in the ordinary position *in situ*). A well-marked wing guards each side of the tip, and a fibre on each side of the throat forms a thickened border to the distal end of the wings. When viewed antero-posteriorly the tips of the wings thus leave the crown free (Plate CV, fig. 1 *b*).

Mesnil gives the numbers of these hooks in the various regions and their variations, as well as the proportions of the anterior region without them at several stages. A slender tapering bristle or two occur above and below the hooks.

At the seventieth foot bristles still occupy the upper division, so that the southern forms from which Mesnil drew up his description differ considerably from the northern in this respect. The winged hooks have receded in the northern.

At the ninetieth foot (Plate XCVII, fig. 2 *b*) the branchia has considerably diminished, but the hatchet-shaped lamella of the superior lobe is even more prominent than at the fiftieth. Moreover, only two of the long bristles remain superiorly, the rest of the area being occupied by four winged hooks. The inferior lamella of the lower division, which is separated by a deep notch, has an abbreviated upper process, and its vertical diameter is shortened. The setigerous ridge beneath, on the other hand, has increased in length and is more prominent, bearing a range of seven winged hooks and a bristle or two above and below. The ventral enlargement or papilla beneath is similar to that at the fiftieth foot. The whole outline of the foot characteristically differs from that of *N. foliosa*.

The foregoing type of foot is little altered in the posterior segments which show (Plate XCVII, fig. 2 *c*) dorsally a small branchia, and a separate hatchet-shaped lamella lying, as usual in the species, behind the bristles which consist of three or four winged hooks with shafts of great strength and more finely tapered tips than in front, and often so worn that it is difficult to see their exact structure. One or two long winged bristles are likewise present. A large gap, which is narrowed in lateral view by the process of the inferior lamella, separates the foregoing from the inferior division. The inferior lamella is short and narrow, and is followed by the web-like projecting setigerous process or edge, bearing six or seven winged hooks of similar structure to the foregoing and an upper and lower bristle or two, smaller and more finely tapered than superiorly, the last process being the conical papilla, which probably is the homologue of a ventral cirrus. Considerable differences exist in regard to the development of the lamellæ of the feet, the finest examples having been met with on Southport sands.

In an example from St. Andrews the tail had been reproduced and formed a smaller continuation of the region in front, all the processes, bristles, and hooks being present in their normal condition. Moreover, ova, with the characteristic capsule and apparently ripe,

occurred in the reproduced segments. The young hooks, as might have been anticipated, showed the main fang and the spike on the crown clearly, indicating that it is friction which renders these minute characters indistinct in this region in ordinary examples.

Reproduction.—A series of eggs and larvæ which appear to belong to this species are figured in Plate XCIV, figs. 4—6 and 12. The early egg (fig. 4) shows little that is definite, but by-and-by (fig. 5) the characteristic pear-shape is assumed, with the spiked surface (fig. 5) which the larva also retains (fig. 6) after the appearance of the prototroch. The egg shown in Plate XCIV, fig. 7, is that of a *Nerine*—it may be one of the earlier stages of the same species as the foregoing.

Claparède and Mecznikow (1868) describe two larval stages of this species, and they identify the Sars-Lovén larva of Busch therewith. The earlier stage is pyriform, with finely reticulated integument, two eyes, mouth, two sets of provisional spinous bristles, proto- and telotroch. In the later stage the pointed snout has four eyes in a transverse series, short tentacles, a body with numerous segments, the first eighteen having provisional spinous bristles longest anteriorly, the rest with ordinary bristles. Each segment has a branchia or a cirrus. In the rudimentary branchiæ they found bacilli (Stâbkenfollikel). The larva is gastrotrochous, and with a ring of long cilia posteriorly. Such forms are common off the eastern shores of Scotland, probably along with the larvæ of *Nerine foliosa*.[1] Busch and Leuckart also show larvæ probably of this species.

Claparède (1868) alludes to the vascular *reté* in the snout and buccal segment, and to the structure of the ova with papillæ on the outer layer (his chorion).

Lo Bianco (1909) fixes the period of sexual maturity of this species at Naples, where it is termed " Esca e ponte che corne," as from February to June, the larvæ being found throughout this period.

Mesnil describes the ripe males as whitish, the females as of a darker green than usual, and eggs and sperms as occurring from the thirty-fifth setigerous segment backward. The eggs are laid at the end of May. He also mentions a young form of fifty-two bristled segments, in which the hooks appeared dorsally on the twenty-first and ventrally on the fortieth segment. In this example the dorsal lamella had a free, pointed upper part, and the hooks had sharper fangs, and he figures them with bifid crowns (in front view). Mesnil found in June larvæ of sixteen to twenty-five bristled segments. The snout is sharper than in the adult, and there are two pairs of eyes. The tentacles have a double row of what he terms bacilliparous corpuscles. The first setigerous segment bears a small number of bristles. After the second the feet are quite visible, and the dorsal lamella becomes pointed, the ventral being always rounded. The winged hooks occur ventrally on the sixteenth segment, dorsally on the nineteenth or twentieth. The body posteriorly has the pre-anal circle, whilst the anal appendage has the form of a sucker. The digestive tube gives the larva its special colour, viz. chocolate-brown in the buccal and the first body-segments, bright green in the second and third segments, colourless in the fourth, in the fifth and succeeding segments deep green (vert tres foncé).

Mesnil[2] gives with considerable minuteness the development of this form, which, at

[1] Such forms may be contrasted with the Sabellarian larva in Plate XCIV, fig. 11. Prof. Caullery has recently given an excellent account of Sabellarian larvæ and the differences between them and the Spionids. 'Bull. Soc. Zool. France,' t. xxxix, p. 168 (1914).

[2] 'Bull. sc. Fr. Belg.,' t. xxix, p. 132, *et seq.*

the aquarium of Wimereux, was rapid, cilia appearing at the third hour. At the seventh hour the prostomium is rounded, with two yellowish-orange eyes and two epaulettes of lateral cilia (from the prototrochal ring). The body is elongated, with a double ring of cilia posteriorly. Three constrictions are evident between the prototroch and the posterior ring, but there is no trace of bristles. The middle part of the digestive tube is greenish. This author (1896) is inclined to think that the *Nereis foliata*, 5 inches long by four lines broad, of Dalyell, is this species, and he is probably correct.

Habits.—Mesnil found that they elevate their tentacles very frequently, and turn the furrow backward, and in repose they are placed on the dorsal surface of the body.

A small form (Plate CI *a*, fig. 3) procured by the dredge on a sandy bottom at St. Andrews in 1866 appears to approach this species or the previous, though there is considerable uncertainty. The snout is bluntly conical, and is marked by two parallel dark patches just within its border, and another occurs at the base of the snout inferiorly. These are rendered more conspicuous by the presence of pure white specks on the pale portions. The eyes are black and four in number, the anterior pair more widely apart, and situated a short distance behind the dark dorsal specks of the snout. The tentacles are slightly speckled with white. The body is short, tapered from before backward, and is pale posteriorly. The tentacles are grooved and ciliated, and palpocils are also present. Each contains a coil of a blood-vessel. The intestine runs in a straight line from end to end, but is constricted at each dissepiment, and the posterior end is richly ciliated. At the tenth segment its calibre is increased, and it acquires a deep, dull yellow hue from the chloragogenous glands. A large blood-vessel crosses the posterior part of the ninth segment on each side. The branchial processes, the first of which is seen in the figure, contain a coil of a blood-vessel, and each is furnished with two bands of cilia. The posterior bristles are all winged, and hooked at the tip. From the eleventh to the twenty-eighth segment the bases of the feet are crowded with comparatively large ova, measuring from $\frac{1}{300}$th to $\frac{1}{350}$th of an inch, each filled with granules and possessing a nucleus.

The exact relationship of this form is at present undetermined, though it may be related to *N. cirratulus*, with which the shape of the snout and the eyes agree, yet no occipital tentacle was seen. The branchia also arises in front—it may be on the second segment. The occurrence of the large ova would appear to indicate maturity in an early form, unless it is a *Spio*.

De St. Joseph (1894) found the intestines of examples (his *N. longirostris*) from Dinard filled with *Rissoa parva*, whilst on the branchiæ *Trichodina pediculus* occurred, and in the tissues of the body encysted Distomes which might have come from the *Rissoa*.[1] The same author found an example with brownish ova, having the typical hexagonal reticulation.

Cunningham and Ramage (1888) describe the ova as pelagic, their external membrane reticulated with hexagonal meshes, and round the longest circumference a single series of vacuoles in the external region of the vitellus, whilst the segmentation is complete and unequal, and a gastrula is produced by epibole. By-and-by the bands of cilia project through this reticulated coating. The authors also represent two later stages of the

[1] See Villot, "Organis. et devel. Tremat. par. Marine," 'Ann. Sc. nat.,' 6^{e} sér., t. vii, pl. ix, fig. 7.

larvæ with about sixteen to seventeen segments. Cunningham,[1] again, describes the segmental organ, which has a tubular inner funnel, and a long duct which opens externally.

Mesnil gives, in his review of the literature of the species, credit to Claparède as having a correct knowledge of its characters, for Delle Chiaje had given an almost unrecognisable figure. He thinks the Neapolitan examples are larger than those at Wimereux, but that the dorsal lamella accompanying the branchia is not terminated by a rounded lobe. He expresses surprise that Claparède did not notice the winged hooks in the dorsal lobe, and does not mention the greenish hue of the body. The *Malacocerus longirostris* of De Quatrefages is the same annelid. He shows reasons for identifying Verrill's *Nerine agilis* with the present form, and so with the *Nerine heteropoda* of Webster. His account of the bristles of various examples is minute.

In 1898 Michel described a bud on a posterior fragment; but a more elaborate study of the process of regeneration of the various parts of this form was carried out by Nusbaum[2] (1905) at Naples, along with that of *Amphiglene mediterranea*. Sections were cut from the living forms, and careful examinations made of the proliferating parts at various intervals. He gives a longitudinal section of the reproduced tail. The broadly spear-shaped tip is smooth.

Genus XCVII.—Scolecolepis, *De Blainville*, 1828.

This genus was established by De Blainville[3] in 1828 for Rathke's[4] *Lumbricus squamatus*. Forgotten by authors, it was resuscitated by Malmgren, and later by Mesnil.[5] Snout (prostomium) with frontal horns. Branchiæ from the first setigerous segment to the last. Anus surrounded by cirri. Always two rows of bristles in each division of the foot. In a certain number of the ventral divisions the posterior row includes winged hooks.

The forms under this head have been variously named, for instead of the genus Spio of O. Fabricius, as revised by Œrsted, Schmarda constituted a new genus, *Colobranchus*, whilst De Quatrefages made two, viz. *Malacoceros* and *Uncinia*. Claparède, again, ranged the species under the old genus *Spio*.

The body-wall in *Scolecolepis vulgaris* (Fig. 115) is constructed anteriorly on a similar plan to that of *Nerine vulgaris*. The central ganglia of the nervous system lie outside the muscles of the dorsum, and the cords rapidly pass downward to the inner end of the widely separated ventral longitudinal muscles, and then to the middle line, each to meet its fellow. As soon as the oral aperture is completed by the frilled hypoderm, an irregular circular coat is apparent, the most conspicuous part being a broad belt, which bounds the mouth posteriorly and ventrally, and stretches to the great muscular masses at

[1] 'Quart. Journ. Micr. Sci.,' vol. xxviii, N.S., p. 247, pl. xviii, figs. 7—8.
[2] 'Zeitschr. f. wiss. Zool.,' Bd. lxxix, p. 222, Taf. xiii—xvi, and Text-figs.
[3] 'Dict. sc. nat.,' Vers, t. lvii, p. 492.
[4] 'Zool. Danica,' iv, p. 39, pl. 155, fig. 1—5.
[5] 'Bull. sc. Fr. Belg.,' 4e sér., t. xxxi, p. 245.

each side. Superiorly a short but distinct circular band appears under the conspicuous central hypodermic elevation. A fasciculated dorsal longitudinal muscle lies below the foregoing layer on each side, the inferior surface being attached to a firm (chitinoid?) sinuous band, which forms a space by its upward curve from a raphe. A somewhat triangular interval occurs in the median line between the muscles. The form of this

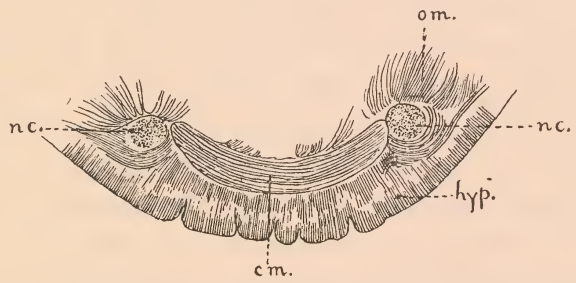

Fig. 114.—Transverse section of the ventral wall of *Scolecolepis vulgaris*, Johnston, before the union of the nerve-trunks.

arch is maintained by strong transverse fibres, which curve from raphe to raphe. At this point on each side is a kind of rosette of muscular fibres, the chief fasciculi being directed downward and outward in transverse section. Outside the foregoing dorsally are various oblique bands, the superior stretching from the dorsal downward and outward to the lateral hypoderm, while the lateral pass downward and inward. The firm (chitinoid?) arch gradually disappears as the dorsal muscles become fully developed.

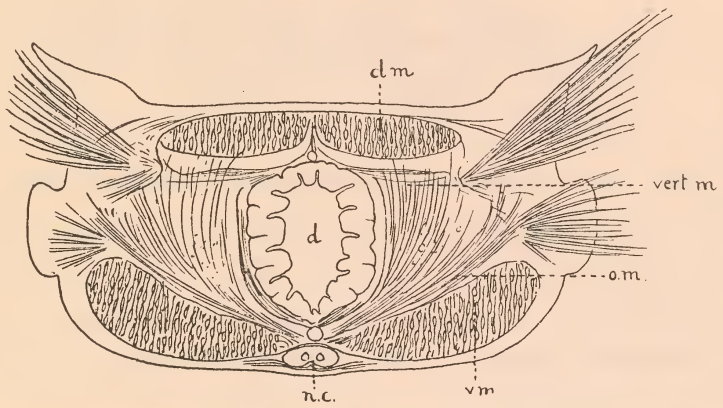

Fig. 115.—Transverse section of the anterior region of *Scolecolepis vulgaris*, Johnston.

Behind the preceding region the arrangement consists, as in *Nerine foliosa*, of the two dorsal and two ventral longitudinal muscles with the interdigitating vertical and oblique bands. No pennate process appears either ventrally or dorsally in the longitudinal muscles, as in *Nerine foliosa*. Whilst the nerve-cords are still separated ventrally, a strong transverse band passes between the attachments of the oblique muscles (Fig. 114). As soon as the nerve-cords meet a large neural canal appears in each toward the inner and lower border, and whilst the increase of the hypodermic area in this region is as marked externally as in the former species, the inner ends of the

ventral longitudinal muscles are nearer each other. The attachments of the oblique in this region are at the upper and outer part of the nerve-area, whilst over the area internally are transverse muscular fibres, to which are attached the fibres from the gut, and in the centre of which is the ventral vessel. On each side of the vessel and touching the circular layer is a band of longitudinal fibres (Fig. 115). The gut is richly folded internally, the folds in section having the cells arranged in a pennate manner.

In *Scolecolepis cirrata*, Sars (Fig. 116), the situation of the central ganglia corresponds with the preceding, and the nerve-cords follow the progress of the oblique muscles toward the ventral surface, each trunk having a small neural canal. The dorsal region of the snout forms a conspicuous mass of the hypoderm in vertical sections in a line with the mouth and the first bristle-bundles, and the lateral areas anteriorly are highly vascular. When the body-wall is completely formed, *e. g.* at a quarter of an inch from the snout, the size of the longitudinal muscles is conspicuous. The dorsal, which at first are somewhat lateral in position, by-and-by form a thick superior arch, and proceed a considerable distance down the lateral wall; whilst the vertical muscles constitute two large curved masses in transverse section, the inner border

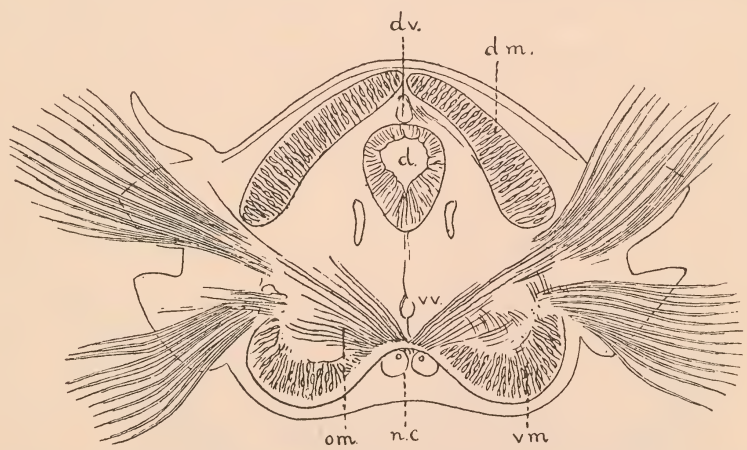

Fig. 116.—Transverse section of the anterior region of *Scolecolepis cirrata*, Sars.

of each being so carried upward that a deep ventral sulcus is formed for the nerve-trunks and their thick hypodermic investment. The attachment of the strong oblique muscles on each side of the mid-ventral line also aids in drawing up the mid-ventral region. The rounded, firm nature of the alimentary canal gives little scope for the development of the vertical fibres.

Posteriorly the trunks still remain hypodermic, the ventral median line being indicated by a flat ridge of that tissue. The ova in this species are very large, and have a thick, minutely punctate zona.

1. Scolecolepis vulgaris, *Johnston*, 1827. Plate XC, figs. 3, 4, and 5; Plate XCVII, figs. 3 and 3 *d*—feet; Plate XCVIII, fig. 2—head; Plate CV, figs. 2 and 2 *b*—bristles and hook; Plate XCIV—ovum.

Specific Characters.—Head truncate, with a frontal tentacle at each side, the anterior border forming the base of a triangle, the apex of which goes to an adherent occipital

tentacle. Eyes absent as a rule in the preparations. The long palpi are pale, marked externally by whitish bars and with the zig-zag blood-vessels. Body $3\frac{1}{2}$ to 4 inches long, slightly narrowed in front and tapering posteriorly to the vent, which has eight cirri. General colour yellowish brown, the ventral surface inclining to fawn. The branchial vessels give a general ruddy hue to the dorsum—from the first foot backward. The first foot carries a small branchia, a hatchet-shaped upper lamella, and a semicircular ventral lamella. At the tenth foot the superior lamella is elongated vertically; its upper edge embracing the branchia and its lower edge forming a rounded lobe. The upper group of bristles points dorsally, and the next forms a long row in front of the superior lamella. All are curved backward and finely tapered, and have no trace of wings. The inferior lamella is short and somewhat hatchet-shaped, with a row of rather short, strong, and finely tapered bristles. Beneath is a small lamella homologous with that seen in *Nerine*. The branchia has considerable dimensions. About the fiftieth foot the elongation of the ventral lamella is marked, and a series of long, winged hooks, with a strong and sharp main fang and two spikes on the crown, appear. Short bristles accompany the hooks, which continue to the posterior end.

Synonyms.

1808. *Lumbricus squamatus,* J. Rathke. O. F. Müller's Zool. Danica, iv, p. 39, Tab. 155, fig. B 1—5.
1815. ? *Spio crenaticornis,* Montagu. Trans. Linn. Soc., vol. xi, p. 199, Tab. xiv, fig. 6 (young ?).
1827–8. *Spio vulgaris,* Johnston. Zool. Journ., vol. iii, pp. 335 and 487.
1828. *Scolelepis squamatus,* De Blainville. Dict. Sc. nat., Vers., t. lvii, p. 492.
1838. *Nerine vulgaris,* Johnston. Mag. Zool. and Bot., vol. ii, p. 70, Tab. ii, fig. 1—8.
1843. *Malacoceros Girardi,* De Quatrefages. Mag. de Zool., p. 10, pl. iii, fig. 1—4.
„ „ *vulgaris,* idem. Ibid., p. 10.
1847. *Aonis wagneri,* Frey and Leuckart. Beiträge Wirbellosen Th., p, 156, Tab. 2, fig. 4—6.
1851. *Nerine vulgaris,* Grube. Fam. Annel., pp. 66 and 134.
1853. ? *Nereis aries,* Dalyell. Pow. Creat., vol. ii, p. 148, pl. xx, figs. 3—6.
1859–61. *Colobranchus tetracerus,* Schmarda. Neue Wirbellosen Th., i, ii, p. 66, Taf. xxvii, f. 210, 210a.
1861. *Nerine vulgaris,* Sars. Forhandl. Vid. Selsk. Christ., p. 65.
1862. *Colobranchus ciliatus,* Keferstein. Zeitschr. f. wiss. Zool., Bd. xii, p. 118, Taf. x, f. 12—18 (young ?).
1865. *Nerine vulgaris,* Johnston. Cat. Worms Brit. Mus., p. 200, pl. xvii, fig. 1—8.
„ *Spio crenaticornis,* Mecznikow. Zeitschr. f. wiss. Zool., Bd. xv, p. 337.
„ *Malacoceros vulgaris,* De Quatrefages. Annel., i, p. 445 (small example).
„ *Nerine vulgaris,* idem. Ibid., ii, p. 664.
„ *Malacoceros Girardi,* idem. Ibid., t. i, p. 442, Tab. x, fig. 12, Tab. xviii, figs. 4, 5, 8 (larger example).
„ *Uncinia ciliata,* idem. Ibid., p. 440.
1867. *Scolecolepis vulgaris,* Malmgren. Annul. Polych., p. 90.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 126.
„ *Nerine* „ Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1879. *Scolecolepis* „ Tauber. Annul. Danica, p. 116.
1883. *Spio vulgaris,* Livensen. Vid. Medd. Nat. Foren. Kjöbenh., p. 99 (102).
„ *Nerine* „ Wiren. Chœtop. 'Vega' Exped., p. 408.
1885. „ „ Carus. Fauna Medit., p. 256.

1888. *Scolecolepis vulgaris,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 640.
„ „ „ Cunningham. Quart. Journ. Micr. Sc., vol. xxviii, N.S., p. 273.
1890. „ „ Malaquin. Annél. Boulonn, p. 47.
1891. *Nerine* (*Scolecolepis*) *vulgaris,* Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 255.
1892. *Scolecolepis vulgaris,* Marenzeller. Zool. Jahrb., Abth. f. Syst., Bd. vi, p. 429.
1894. *Spio vulgaris,* Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 94.
„ *Nerine floræensis,* De St. Joseph. Ann. Sc. nat., 7e ser., t. xvii, p. 77, pl. iv, figs. 91—100.
1895. „ *Girardi,* idem. Ibid., 7e ser., t. xx, p. 229.
1896. „ *vulgaris,* Benham. Camb. Nat. Hist., vol. ii, p. 322.
„ *Scolecolepis Girardi,* Mesnil. Bull. Sc. Nord et Belg., t. xxix, p. 140, pl. viii, fig. 15—28.
1897. „ *vulgaris,* Ehlers. Hamb. Magell., Samm., p. 86.
1901. „ „ idem. Polych. Magell. Chil., p. 165.
1904. „ „ . Journ. M. B. A., vol. vii, p. 227.
1909. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 159.
„ „ *Giardi,* idem. Ibid.
1910. „ *vulgaris,* Southern. Proc. R. Irish Acad., vol. xxviii, p. 235.
„ „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1913. „ „ Giard. Œuvr. Divers, p. 56.

Habitat.—Not uncommon in sand between tide-marks around the shores of Britain. It is less common than *Nerine foliosa* at Lochmaddy. It occasionally frequents cracks in sandstone (R. McIntosh). The largest examples are from Lochmaddy and St. Andrews. Those from Guernsey and Herm are considerably smaller. Howth Head, Dublin (Southern). Torquay (Elwes).

Elsewhere it is met with in Norway (Sars); Sweden (Lovén, Goës, and Malmgren); shores of the North Sea; France (De Quatrefages, Keferstein, Tauber, Giard, De St. Joseph, Mesnil); Mediterranean (Grube); Siberian coast and Behring Sea (Wirén); Magellan (Ehlers).

Head (Plate XC, fig. 4) truncate with a short tentacle at each side, the anterior edge between them being slightly crenate and pale. Viewed from the dorsum it forms a triangle, to the apex of which is posteriorly attached what appears to be a homologue of the occipital tentacle in *Nerine*, but it is fixed. It is slightly dilated at its commencement, and then tapers to a point behind. Eyes generally absent. From the sides of the snout pass the two large and long tentacles which are pale, marked externally by whitish bars, and enlivened by a zig-zag blood-vessel in the centre. They are active, muscular organs, coiling and twisting in various ways.

Body (Plate XC, fig. 3) $3\frac{1}{2}$ to 4 inches long, slightly narrowed in front and gradually tapering posteriorly to the tail, which is terminated by the vent with eight cirri around it[1]. The body is somewhat rounded in front, though the ventral surface is in contraction more convex than the dorsal. Posteriorly there is a tendency to flattening in contraction, but toward the tail it is again somewhat rounded. These features are less conspicuous in a living and healthy example, as indicated in the coloured drawing. The dorsum is marked by transverse lines, and on the ventral surface each

[1] Mesnil says the filiform anal cirri resemble the terminal lamellæ of the body at the tail. De St. Joseph gives 20–30, Mesnil 16 filiform anal cirri.

segment anteriorly shows two rings. Behind the middle, however, the double ring is indicated only in the median band. The general colour is yellowish-brown, the ventral surface inclining to fawn. Dorsally the rich red of the transversely arranged branchiæ give it a general ruddy hue, whilst ventrally the median blood-vessel causes a dull or slightly reddish longitudinal band; segments one hundred and twenty to three hundred (De St. Joseph). The buccal segment shows two small pads or papillæ ventrally—one at each side of the mouth, and dorsally it forms a process at each side of the snout behind the short anterior tentacles.

The fæcal masses consist of fragments of algæ, ova of other forms, fragments of sessile-eyed crustaceans, and a little muddy *débris*.

The first foot (Plate XCVII, fig. 3) differs from that in *Nerine*, since it carries a distinct though small branchia, the vascular loop of which does not go quite to the tip. A somewhat hatchet-shaped lamella with its dorsal edge produced into a lanceolate, free tip follows, and represents the rest of the upper division, whilst the inferior has an almost semicircular flap. The hypodermic tissue in these flaps is somewhat regularly arranged in a radiate manner. The bristles of the upper division form a fan, and are in two sections, the dorsal much longer, more slender, and more finely tapered, and an inferior group of shorter bristles also with finely tapered tips. Both sets are directed obliquely upward and inward. The bristles of the ventral division form a fan-like row similar in structure to the shorter series above them. All these bristles lie in front of the lamellæ.

The form of the foot gradually changes, so that at the tenth (Plate XCVII, fig. 3 *a*) the superior lamella has been elongated vertically, its upper edge embracing the branchia, whilst its inferior forms a rounded lobe ventrally. The upper group of golden bristles still points dorsally, but they are now shorter, whilst the lower group in this division forms a long row in front of the lamella. All are curved backward and finely tapered, have no trace of wings, and have longitudinally striated shafts (Plate CV, figs. 2 and 2 *a*). The lamella of the inferior division is short and somewhat hatchet-shaped, and has in front of it the row of rather short, strong, and finely tapered bristles. Just as those in the upper division are visible in the notch beneath it, so those of the inferior division are seen in the notch above the lamella. Beneath the foregoing is a small lamella probably homologous with the papilla present in *Nerine*. The branchia on this foot has considerable dimensions.

No noteworthy change occurs in the twenty-fifth foot, except the increase of the ventral lamella, and the same may be said as far as the fiftieth. About the fiftieth, however (Plate XCVII, fig. 3 *b*), the elongation of the ventral lamella is conspicuous, and a series of long, winged hooks occur in this division. These have stout, curved shafts, a strong and sharp main fang, and two well-marked spikes on the crown (Plate CV, fig. 2 *b*). The lower hooks project beyond the margin of the lamella, the upper, which reach about one quarter from the top, being within the margin. Short bristles accompany the hooks, and about three are prominent ventrally. The notch between the divisions of the foot is larger, but less deep than in front. De St. Joseph found that the hooks made their appearance between the thirty-ninth and fifty-second, whilst Mesnil found that they appeared between the thirty-fifth and thirty-seventh. A typical foot in life is shown in Plate XC, fig. 5.

Except that there is a diminution in the size of the feet posteriorly, the general arrangement at the hundredth foot is similar. The dorsal bristles, however, are considerably longer and more slender. The branchia remains fairly large, and some distance in front of the tail is still conspicuous (Plate XCVII, fig. 3 *c*). The superior lamella has become more convex and deeper, and the length of the slender dorsal bristles much increased. The ventral hooks retain the same type as in front, and are accompanied by the short bristles. Toward the tip of the tail (Plate XCVII, fig. 3 *d*) the branchiæ are very short, indeed, in the last segments rudimentary.

In life the lamellæ of the feet as well as the branchiæ, which meet those of the opposite side in front, are muscular, and undergo various movements. The ventral lobe forms a flattened fan with a regular series of bristles in front.

Reproduction.—On May 10th a female was laden with ova having the peculiar spini-reticulate capsule (Plate XCIV, fig. 13), and some were not quite round. The central region was pale and the contents granular.

A young example, about $\frac{1}{4}$ of an inch in length, was found at St. Andrews in May (R. McIntosh). Such probably represents the growth of a year.

Habits.—A dweller in sand, and an active and restless form.

The *Colobranchus tetracerus* of Schmarda (1863) may be either this form or *Scolecolepis fuliginosus*.

It is probable that the *Uncinia ciliata* of De Quatrefages (1865) refers to this species, and there is little in the description to separate it. The same may be said of Keferstein's *Colobranchus ciliatus*.

De St. Joseph (1894) described this as a new species (*Nerine florœensis*), basing the distinction amongst other things on the tridentate crotchets which appear from the thirty-second to the fifty-second segment, but in the ordinary form two spikes occur above the main fang, and the figure[1] appears to have been drawn from a compressed or softened example. The author regarded this form of hook as rare, but such is probably due to a misapprehension. He states that the anus is surrounded by twenty to thirty cirri, and that he has seen two of these longer, and occasionally bifurcate as an abnormality. He identifies it with *Malacocerus Girardi*. A young example of 10 mm. had four eyes arranged in a trapezoid and sixty-nine segments.

Mesnil (1896), like De St. Joseph, could not satisfy himself as to the identity of Johnston's *Nerine vulgaris* with De Quatrefages' *Malacocerus vulgaris vel Scolecolepis Girardi*. He points out that what was sent from Heligoland as *Nerine vulgaris*, Johnston, pertained to *Scolecolepis fuliginosa*, Claparède. Ehrenbaum considered *Aonis Wagneri*, Leuckart, identical with the supposed *Nerine vulgaris*. He thought *Colobranchus ciliatus*, Keferstein, a distinct form, a view not now held.

2. Scolecolepis fuliginosus, *Claparède*, 1868. Plate XCVIII, figs. 4—4 *b*—head, tail, etc.; Plate XCVII, figs. 4—4 *b*—feet; Plate CV, figs. 3—3 *b*—bristles and hook.

Specific Characters.—Head in lateral view (in spirit) more pointed than that of *S. vulgaris*, with a median cleft in front. Constriction behind the broad base of frontal

[1] 'Ann. Sc. nat.,' sér. 7e, t. xvii, Pl. IV, fig. 96.

tentacles more marked. Palpi (long tentacles) with dark bands and a cream-coloured touch on prostomium, with black pigment on that region and the dorsum. Body about three inches in length, smaller as a rule than *S. vulgaris*, with longer branchiæ anteriorly, tapering a little in front, but much more posteriorly, where it ends in a vent with eight flattened cirri. Segments numerous (90—160) and distinctly marked. Black pigment at each side of the mouth. First foot carrying a larger branchia than in *S. vulgaris*, and the superior lamella is narrower and with a more acute tip; inferior lamella also narrower and more prominent. The bristles are similar, but more delicate. At the tenth foot the branchia forms a long, richly ciliated process; the upper lamella is hatchet-shaped, pointed and free superiorly; inferior lamella capstan-shaped. The long bristles at the upper edge of the dorsal tuft have very narrow wings. The shorter forms dorsally and ventrally are finely tapered. The branchia and superior lamella diminish before the fiftieth foot, about which three or four winged hooks appear in the ventral division. These hooks differ from those of *S. vulgaris* in the larger angle made by the main fang with the neck, in its not very acute tip, and in the presence of only a single spine on the crown. The ventral hooks and accompanying short bristles continue to the posterior end.

Colour dull greenish, with black pigment anteriorly (Lo Bianco).

Synonyms.

1837. *Spio lævicornis,* Rathke. Fauna der Krym, Mém. Sav. Étr. Acad. St. Pétersb., t. iii, p. 421, pl. viii, fig. 1—6.
1847. *Aonis Wagneri,* Frey and Leuckart. Beiträge wirbellosen Th., p. 156, pl. i, fig. 10.
1868. *Spio fuliginosus,* Claparède. Annél. Nap., p. 322, pl. xxiii, fig. 1.
„ „ „ Claparède and Mecznikow. Zeitschr. f. wiss. Zool., Bd. xix, p. 7 (sep. abdr.).
1875. „ „ Marion and Bobretzky. Ann. Sc. nat., 6e sér., t. ii, p. 84.
„ „ „ Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1885. „ „ Carus. Fauna Medit., p. 255.
1888. *Nerine vulgaris,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 636.
1892. *Scolecolepis vulgaris,* Marenzeller. Zool. Jahrb., Abth. f. Syst., vi, p. 427.
1893. *Spio fuliginosus,* Lo Bianco. Atti d. R. Accad. d. Sc. Napoli, vol. v, ser. 2, No. 11, p. 27.
1896. *Scolecolepis fuliginosa,* Mesnil. Bull. Sc. Fr. Belg., xxix, p. 132, pl. vii, fig. 21—27, pl. viii, figs. 1—11.
1908. *Spio fuliginosus,* Salensky. Bull. Acad. Impér. St. Pétersb., p. 698.
1909. „ „ Lo Bianco. Mitt. Zool. Stat. Neap., Bd. xix, p. 587.
„ *Scolecolepis fuliginosus,* McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 160.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1914. „ *fuliginosa,* Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p, 96.

Habitat.—Not uncommon between tide-marks at Luccomb Chine, Isle of Wight, in sand (W. C. M.); between tide-marks at Whitby (Dr. Carrington); deep sea fishing off St. Andrews Bay (E. McIntosh); Torquay (Elwes); Blacksod Bay (Southern).

It is found abroad in the Mediterranean, Naples (Claparède and Panceri); shores of France (Mesnil). Claparède procured it along with *Capitella capitata* and *Polydora Agassizii* in the harbour of Naples. Sebastopol (Salensky).

Head (Plate XCVIII, fig. 4) in lateral view somewhat more pointed than in *S.*

vulgaris, whilst from the dorsum a distinct median cleft occurs in front (Plate XCVIII, fig. 4), and the tentacles (frontal "horns") are longer than in the former species, a slight crenation moreover appearing in the preparations on the anterior border between the tentacle and the median furrow on each side. The constriction behind the broad base of the frontal tentacles is marked in this species, and gives a character to the snout. The tissues of the head generally are more translucent than in the common form. Behind the frontal tentacles the head is produced into a triangle with the base in front, the posterior peak ending in a ridge between the eyes without the special differentiation characteristic of the previous species. The eyes form an elongated and somewhat kidney-shaped mass on each side of this ridge with a smaller pair behind (Claparède and Mesnil).

The long tentacles are absent in all the preparations, but probably they correspond in structure with those of *S. vulgaris*.

Mesnil observes that the French form has transverse black bands on the tentacles (palpi), a cream-coloured touch appears laterally on the prostomium, and various touches of black pigment occur on this region.

The *body* is about 3—4 inches in length, smaller as a rule than *S. vulgaris*, from which it is readily distinguished by the longer branchiæ in the anterior region. It tapers a little in front, but much more distinctly posteriorly, ending in a moderately attenuate tail with the anus at the tip and surrounded by about eight flattened cirri, the two dorso-lateral being more developed than the others (Mesnil) (Plate XCVIII, fig. 4 *a*). Segments about 160. The body is firm, somewhat flattened dorsally, and convex ventrally, where there is a median band. Posteriorly it is more definitely flattened. The segments, though numerous and narrow, are distinctly marked throughout. The mouth opens inferiorly a short distance behind the tip of the snout, the lips, which slope from without backward and inward, being marked by brown pigment.

The first foot differs from that of *S. vulgaris* in carrying a proportionately larger branchia, in the more acute tip of the narrower superior lamella, and in the narrower and more prominent inferior lamella, which is somewhat truncated distally. The bristles, both superiorly and inferiorly, are more delicate, but similarly arranged.

The branchia increases in length to the tenth foot, where it forms a long, richly ciliated process. The upper lamella is hatchet-shaped, viz. pointed and free superiorly and with a rounded blunt border inferiorly, the notch between the two lamellæ being distinct, with symmetrical sides. The inferior lamella is in outline capstan-shaped. The long bristles at the upper edge of the dorsal tuft have very narrow wings (Plate CV, fig. 3). The shorter forms dorsally and ventrally are finely tapered.

At the twenty-fifth foot (Plate XCVII, fig. 4) the branchia is still large, though after the fifteenth a slight decrease occurs (Mesnil), but there is no free process of the diminished superior lamella, only a little conical projection marking its position. The lamella approaches a semicircular outline with an abrupt margin inferiorly. The wings on the long superior bristles are more distinct. The notch between the lamellæ is still wide, and the vertical diameter of the inferior lamella has increased, the outline, however, remaining capstan-like. The shorter bristles, superiorly and inferiorly, are as figured. A bristle with a hooked tip is shown in Plate CV, figs. 3 *a*.

At the fiftieth foot (Plate XCVII, fig. 4 *a*) the diminution of the branchia is marked,

and so with the superior lamella, which is narrower, with a rounded margin dorsally and ventrally. The inter-lamellar notch is larger; the ventral lamellar notch is narrower, and the upper and lower margins slope evenly inward, so that the capstan-like outline is lost. The superior bristles are still in two groups, and both occupy a considerable distance of the margin. In the ventral division a few slender tapering bristles (pertaining to the anterior row) occur superiorly and inferiorly, whilst the centre is occupied by three hooks (posterior row). These (Plate CV, fig. 3 *b*) have a forward bend of the shaft, and then a backward curve at the tip, which has well-marked wings. The tip has a strong and not very acute main fang, and a single spine on the crown, and thus it differs from that of *S. vulgaris*. A compressed foot viewed from the ventral surface is shown in Plate XCVIII, fig. 4 *b*. Mesnil found the hooks appearing from the forty-second to the forty-fifth foot on the French shores. Moreover, the shorter rows of bristles had grains of yellowish-orange pigment on them.

In the posterior feet (Plate XCVII, fig. 4 *b*) the branchia still retains a noteworthy size, and the superior lamella shows a tendency to form a peak superiorly. The lower lamella is almost on a level with the rounded margin of the region. The setigerous process has a series of hooks with intermediate short bristles, besides a few above and below. The hooks and bristles retain the same structure, though the latter are perhaps more slender.

Reproduction.—On July 19th the cœlom of the females had many nearly ripe ovoid ova with the peculiar capsule.

Lo Bianco (1909) states that at Naples the period of sexual maturity is from October to April.

Claparède (1868) describes and figures the space in which the tentacular vessels are held as filled with a mobile tissue in the form of a multitude of drops apparently sarcodic. The segmental organs form a simple loop from the dissepiment to a point between the feet. The general tissues of the animal have many bacilliparous follicles.

Claparède and Mecznikow (1868) found ripe examples of this species at Naples during the winter, the white sperms of the male issuing by the segmental pores, and they describe the development of the egg from the early stages of its unequal segmentation to the escape of the trochophore with its two pigment spots (eyes) anteriorly, and its tuft of cilia in front. The next stage presents the prototroch, mouth, and lateral dimples of the body; whilst, after eight days more, there are long, prominent bristles, the regions of the alimentary canal, six eyes in a transverse row in front of the prototroch, a telotroch, and four distinct segments of the body.

Mesnil (1896), in his detailed account of this species, gives the number of the dorsal and ventral hooks in the various segments, and other minute features. He also (1896) makes two varieties of this form, viz. var. *microchæta* from Naples, and *macrochæta* from the Channel, and of the latter two sub-divisions, *minor* and *major*, but such are mainly of interest in demonstrating the variability of the species under diverse conditions.

A form which shows certain differences in the shape of the dorsal lamellæ, and which approaches Mesnil's *S. Martinensis*, comes from St. Andrews. The edge of the dorsal lamella is more rounded.

3. Scolecolepis (*Laonice*, Malmgren) cirrata, *Sars*, 1851. Plate XCVII, fig. 5—foot; Plate XCVIII, figs. 3—head; Plate CV, figs. 4 and 4 *a*—bristle and hook.

Specific Characters.—Head short, smoothly rounded on the broad anterior edge or slightly bilobed. A somewhat triangular ridge with the base in front passes backward and ends in a point posteriorly, from the apex of which a small subulate tentacle springs. Eyes, two in number, one on each side of the ridge in front of the tentacle. Lamella at the base of the long tapering palpi. Body about 1—2 inches in length, little tapered anteriorly, so that with the shortness of the snout it has a truncated aspect. Dorsum somewhat rounded, ventral surface deeply grooved from front to rear. It tapers to a moderately slender tail, which ends in a cirrate margin with 12—15 long subulate cirri. First foot carries a branchia and a large hatchet-shaped lamella, with a conical margin superiorly and a somewhat straight border inferiorly. The ventral lamella is nearly as large, bluntly conical superiorly and curving downward to a sharp angle inferiorly. Dorsal bristles capillary, the long tuft being superior, the shorter inferior.

Branchiæ continue of considerable size to the twenty-fifth foot; the great dorsal lamella remains nearly as at the tenth foot, and is almost reniform. The ventral lamella is slipper-shaped, the broad end being uppermost, and both are free. The winged hooks appear about the twenty-fifth foot, have a slight dilatation of the shaft above the backward curve, then gradually diminish to the throat, from which the main fang comes off at a little more than a right angle, and a single spike occurs above the crown. Two slender capillary bristles are below the hook. The bristles become very long and attenuate posteriorly, and wings are not evident.

Synonyms.

1851. *Nerine cirrata*, Sars. Nyt Mag. f. Naturvid., vi, p. 207 (Reise i Lofoten og Finmark).
1859 „ „ Danielssen. Reise, 1858, Norske Vidensk. Skrift., iv, p. 118.
1861. „ „ idem. Forh. Vid.-Selsk. Christiania, p. 64.
„ „ „ Danielssen. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 52.
1865. „ „ De Quatrefages. Annel., t. ii, p. 665.
1867. „ „ Malmgren. Annul. Polych., p. 91, Tab. ix, fig. 54.
1868. „ „ Sars. Vidensk.-Selsk. Forhandl., p. 10 (sep. copy).
1873. *Scolecolepis cirrata*, idem. Bidrag Christ. Fauna, p. 62.
„ „ „ Verrill. Rep. Fish and Fisheries U.S.A., p. 602.
1875. „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 62.
1878. „ „ McIntosh. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 506.
1879. „ „ Tauber. Annul. Danica, p. 116.
„ „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 53.
1883. *Nerine cirrata*, Wirén. Chætop. 'Vega' Exped., p. 409.
„ *Spio* „ Levinsen. Nat. For. Vid. Meddel., p. 100.
1884. *Scolecolepis cirrata*, Webster and Benedict. Rep. Comm. F. and F., U.S.A., for 1881, p. 726.
1885. „ „ McIntosh. 'Challenger' Annel., p. 380.
1886. *Spio cirrata*, Levinsen. Kara-Havets, etc., p. 9.
1889. „ „ Marenzeller. Arch. f. Naturges., Bd. lv, p. 132.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 95.

1896. *Laonice cirrata,* Mesnil. Bull. Sc. Fr. Belg., t., xxix, p. 116.
1897. *Spio cirratus,* Michaelsen. Polych. deutsch. Meere, p. 152.
1909. *Scolecolepis* (*Laonice*) *cirrata,* McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 160.
„ *Aonides cirrata,* Fauvel. Bull. Inst. Ocean., 142, p. 4.
1913. „ „ idem. Bull. Mus. Hist. Nat., No. 2, p. 9.
1914. *Laonice cirrata,* Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 97.

Habitat.—Dredged in 80—100 fathoms in St. Magnus Bay, Shetland, July 1867; and in 85 fathoms in the same locality in 1868; 110 fathoms thirty miles west of Blasquet, S.W. Ireland; in Valencia Harbour, May 1870 (Dr. Gwyn Jeffreys). S.W. Ireland, 23—38 fathoms, long. 55, 1886; Ballinaskellig Bay (R. I. A.). Plymouth (Spence Bate and Brooking Rowe). Clew Bay (Southern). From the contents of the alimentary canal it would seem to be partial to fine mud.

It ranges to Canada, 313 fathoms (W. C. M.); Spitzbergen, Greenland, Sweden, and Finmark (Malmgren). Atlantic coast, U.S.A. (Verrill, Webster and Benedict); Siberian coast and Behring Sea (Wirén); Kara-Havets (Levinsen). Large examples come from Norway, 300 fathoms (M. Sars and Canon Norman).

The *head* (Plate XCVIII, fig. 3) of this species is remarkably short, and the snout is either smoothly rounded on the anterior edge, or slightly bilobed. A somewhat triangular ridge with its base anteriorly passes backward and ends in a point posteriorly. A small subulate tentacle springs from the apex. The eyes are situated on each side of the ridge posteriorly, but in front of the tentacle. They are two in number. The long tentacles are absent in every preparation, but the lamella at their base posteriorly is present.

The *body* tapers little anteriorly, so that with the shortness of the snout it has a truncated aspect. The dorsum is somewhat rounded, whilst the ventral surface is deeply grooved from the hind lip backward to the tip of the tail. From the broad and deep anterior region the body gradually tapers backward to a moderately slender tail, which ends in a regularly crenate margin with a series of long subulate cirri from 12—15 in number. Whilst the anterior part of the body is lamellar from the great development of the flaps of the feet, the posterior region is considerably smoother dorsally and laterally from the diminution of all the appendages.

The first foot carries dorsally a small subulate branchia, and a large hatchet-shaped lamella, with a conical edge superiorly, and a somewhat straight margin inferiorly. The setigerous process in front of it has a fan-shaped series of rather long, slender, and finely tapered wingless bristles, the most slender as usual being superior and pointing upward. The ventral lamella is nearly as large, but it is bluntly conical superiorly, and from this it curves downward to a sharp corner inferiorly. In the notch between the lamellæ are two small conical papillæ. The ventral bristles are shorter, but as finely tapered. No differentiation inferiorly is present.

The branchia continues of considerable size anteriorly, though in lateral view the great lamella somewhat overshadows it. At the tenth foot it forms a large subulate organ tapering gradually from base to apex. The great and almost reniform dorsal lamella succeeds the vertical diameter of the body, and though it does not reach the ventral margin, yet it stretches considerably over the dorsum. The inferior margin is

rounded, the superior is bluntly pointed externally and curved internally, the free distal edge stretching about half the length of the branchia. The upper bristles of the division are long, taper to very fine hair-like points, and have extremely narrow wings. The rows beneath are shorter and stronger, but with finely tapered tips and more distinct wings (Plate CV, fig. 4). Two groups are present in the ventral also, viz. an upper more attenuate series, and a lower with broader wings, but with finely tapered extremities. The ventral lamella is somewhat slipper-shaped, the broader end being uppermost, and both are free (Plate XCVII, fig. 5—fifteenth foot).

The ligulate branchia at the twenty-fifth foot is nearly of the same size as at the tenth and twelfth, and the great dorsal lamella shows little change, though it scarcely reaches so far upward. The ventral lamella is of similar size to that of the tenth and twelfth, but there is a tendency to a peak at its upper and outer angle. The bristles formerly described remain, and in addition two longer, curved bristles occur at the extreme ventral edge. Occasionally the branchiæ bear Loxosomæ (Fig. 117).

Fig. 117.—Branchia of *Scolecolepis cirrata*, Sars, with Loxosomæ. Shetland.

Not a single British example is complete, and few fragments of the anterior end go beyond the twenty-fifth foot; but in a Canadian specimen the fiftieth foot presented a ventral row of the winged hooks, so that the transition, judging from descriptions, would appear to take place near this foot. The upper dorsal bristles have greatly increased in length.

Behind the branchial region the feet are considerably diminished, and the superior and rather narrow lamella shows a rounded and partly free dorsal border, whilst the ventral edge runs gradually into the body. The dorsal bristles have been increasing in length, and are now very long and slender, with hair-like tips devoid of wings.

The inferior division presents no distinct lamella, though a conical process occurs inferiorly where there are about two slender capillary bristles. The winged hooks (Plate CV, fig. 4 *a*) show a slight dilatation of the shaft above the backward curve, then they gradually diminish to the throat from which the main fang comes off at very little more than a right angle, and it does not form a very acute tip. A single spike occurs on the crown (lateral view). The glands are well developed in this region, and continue to the tail. The dorsal bristles become still more slender toward the tail, stretching as long hair-like processes from the feet.

What seems to be a variety of this species comes from deep water in the 'Triton' (1883), and also from 313 fathoms in the Gulf of St. Lawrence, Canada, in 1872.

Unfortunately the example from the 'Triton' is fragmentary, about twenty-five segments of the anterior region being present, and more or less softened. The head is smoothly rounded in front, and the aspect considerably less truncate than in the ordinary form. No gill is visible on the first foot, but the condition of the specimen may account for this. The tenth foot also has a more acute dorsal lamella and better developed bristles, but there is little difference in the ventral lamella and the bristles of the division. The larger modified bristles at the ventral edge have not yet shown themselves, but they are apparent at the twentieth foot, where there are three, and they slightly differ from the typical form in their comparative slenderness, and in the finer dots. The winged hooks occur in the typical segment, and they show a similar, though perhaps more delicate, structure than in the ordinary form.

Scolecolepis (I). Plate CV, fig. 6—bristle.

Synonym.

1909. *Scolecolepis* (I), McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 176, pl. vi, fig. 9.

Habitat.—Dredged in 164 fathoms off the west coast of Ireland in the 'Porcupine' Expedition of 1869, on a bottom of greyish sand, stones, and coral.

This fragmentary *Scolecolepis* (I) shows certain novel features. The head is short, with a slightly bilobed anterior border, which forms the base of a triangle ending in a short subulate tentacle posteriorly. No eyes are visible in the preparation. A little behind the anterior edge of the snout ventrally are two prominent, rounded peristomial papillæ in front of the mouth. The fragmentary body consists of about sixteen segments, at the posterior end of which new segments and a tail are developing. It is flattened dorsally and grooved in the median line ventrally, whilst the sides are flanked by an extraordinary development of dull golden bristles, which at first sight make an approach to the condition in *Euphrosyne*. A kind of flap, vertically elongated, occurs immediately behind the snout, but it does not appear to have either bristle or branchia. The first bristled foot carries a branchia and long tufts of bristles dorsally and ventrally; but the condition of the foot negatives a minute description. The bristles are of comparatively great length and strength, are finely tapered, and conform to the usual arrangement in *Scolecolepis*, the upper of the superior division being longest and curved upward and backward. No wings are visible. The bristles of the inferior division form a dense group shorter than the superior, and they are curved backward. Focussing indicated a margin on each side of the tapered tip, but there is no distinct wing.

The great development of the superior lamella is soon conspicuous, and at the tenth foot[1] it forms a large lanceolate crest on the dorsum, the outer or inferior edge being rounded, whilst the inner is acute. The branchia appears to be subulate and to stretch inward over the dorsum, but all had disappeared during the examination of the minute specimen. The remarkably dense, strong, and boldly curved dull golden bristles curve upward and backward, and narrow wings are evident on the lower bristles and many others

[1] 'Ann. Nat. Hist.,' ser. 8, vol. iii, pl. vi, fig. 9.

in the division. The upper, as usual, are longer and more slender, but also present indications of wings. The ventral lamella is separated from the dorsal by a notch with a papilla, and is somewhat capstan-like, only the edges slope to a low cone in the centre. Its bristles curve downward and backward, taper to a fine point, and have narrow wings (Plate CV, fig. 6). Moreover, they are all minutely dotted or dappled, and many of the upper forms show a peculiar mark just below the tip, as if a portion had been scooped out. It is possible that friction may be connected with this disappearance.

The condition of the posterior region is unknown, but at the sixteenth foot the superior lamella is still large and lanceolate, with a rounded outer or inferior margin, and the bristles have rather increased in length. The ventral lamella, however, is smaller and of the form of a short capstan. The bristles are also longer, and a ventral group of four or five larger, longer, and boldly curved bristles is differentiated, each tapering to a fine point, and the wings are more distinct.

Genus XCVIII.—Spio, *O. Fabricius*, 1785.

Prostomium conical or rounded, without frontal processes; eyes one or two pairs. Pair of long tentacles (peristomial). Branchiæ from the first setigerous segment to the end and joined by laminæ. Body filiform, pellucid, segments similar, proboscis partly extrusible; unarmed. Anus furnished with cirri (quadrifurcate, Œrsted). Always two rows of bristles which are capillary in the dorsal division. After a certain segment (8th—15th) the posterior row is formed of winged hooks. Tubes composed of sand.

O. Fabricius[1] in 1785 founded this genus for two annelids with two long tentacles, formerly termed *Nereis seticornis* and *N. filicornis*, and his descriptions and figures aid in clearing up the ambiguity which surrounds the species of *Spio*. Under the same head Johnston[2] (1838) included *Nerine* and *Leucodore*. Œrsted[3] (1844) retained the genera *Spio* and *Nerine*, which he distinguished by the form of the dorsal lamellæ thus:—Pinnis lamellis instructis—*Nerine*; Pinnis mamilla parva instructis—*Spio*. The genus *Spio* is one of the genera of his Ariciæ naidinæ along with the genus just mentioned, *Leucodorum*, and *Disoma*. He gives two minute species, *S. seticornis* and *S. filicornis*. Yet those of Fabricius were 3 inches and 1 inch long respectively. Claparède[4] (1868) showed that this distinction was artificial. He pointed out that in *Spio* the superior lamella constitutes a lobe soldered to the base of the branchia or disappears completely. Mesnil assumes that Malmgren complicated the question by reviving the generic name, *Scolecolepis*, and undid the advances made by Claparède, a view which cannot now be held. Yet he says that Malmgren conserved the genus *Spio* without definitely defining it, and described under the name *Spio filicornis*, O. Fabricius, a species which he (Mesnil) has demonstrated to be very near his form, *Spio Martinensis*, and he doubts if Malmgren's form is that of Fabricius, though the figure pertains to the same genus. He does not

[1] 'Gesellsch. naturf. Freunde,' Bd. vi, p. 256.
[2] 'Mag. Zool. and Bot.,' vol. ii, p. 66.
[3] 'Arch. f. Naturges.,' Bd. x, p. 103, 1844.
[4] 'Annél Nap.,' p. 321.

accept Levinsen's [1] inclusion of the genus *Nerine* of Johnston under *Spio*. He is unaware of any species coming within the description of the two species of O. F. Müller,[2] as given by Fabricius,[3] since they have a pointed and rounded snout, two anal papillæ, and branchiæ throughout the body. The first is 3 inches long and has sixty-eight to seventy-six segments; the second 1 inch with forty-eight segments. He thinks the legendary plate of De Blainville (19, 'Dict. Sc. nat.'), giving a figure of *Spio seticornis*, is probably a specimen of Suriray's 2 or 3 lines long. Mesnil did much for this family in his able memoir in Giard's 'Bulletin.'

Cuvier (1817) linked on *Spio* as a member of his second Order, the Dorsibranchs, the first division of which included the Nereids and Eunicids, with jaws, the second those without them, like *Spio* and *Arenicola*, yet the Polynoids, with their horny jaws, are not in agreement with this arrangement.

Spio was included by Savigny (1820) amongst the Nereids, along with *Polydora*, and in this association he was followed by De Blainville.

Audouin and Milne Edwards (1834) placed the genus *Spio* under their Appendix of forms *Incertæ sedis*, the chief character being the very long, slender tentacles. They considered that they were Nereids, perhaps approaching *Syllis*, since they had an unarmed proboscis and uniramous feet deprived of branchiæ.

Grube made three species, viz. *Spio filicornis* (Müller) Fabricius, *Sp. seticornis* (Müller) Fabricius, and *S. crenaticornis*, Montagu.

Dalyell's [4] (1853) *Nereis parva* apparently belongs to this genus, though the species is uncertain.

De Quatrefages (1865) placed the genus *Spio* in the category of uncertain forms, and following *Polydora*. He points out that the term *Spio* was used by König for *Terebella cirrata*, and adopted by Fabricius for two singular species, *Spio seticornis* and *S. filicornis*, which he grouped with the Nereids, in his 'Fauna Grœnlandica.' The descriptions of these, however, are so imperfect that their identification is uncertain.

Claparède and Mecznikow [5] (1868) described an early larva of *Spio Mecznikowianus* in the telotroch condition, with two eyes, an œsophagus, largely distended body, and a few tufts of cilia on the thickened ventral surface. A structure, which they term a developing tentacle, lies behind the head. They also describe the segmental organs of this species, which are normal in structure, and open behind the feet. Moreover, a peculiar spermatophore is formed in the male, and finds exit by the segmental organs.

Kuhlgatz[6] (1898) describes a new species of *Spio* (*S. inversa*), from the North Sea, which so far as can be observed approaches *Pygospio elegans*. He gives an interesting discussion as to the species of *Spio* described by former authors, and a table indicating the distinctive characters of the several species.

Giard[7] (1913) thought Montagu's *Spio crenaticornis* was the same as *Aonis Wagneri*,

[1] 'Vid. Meddel. Nat. For.,' 1883, pp. 92—380.

[2] 'Zool. Danica Prod.,' 1776, Nos. 2639 and 2640.

[3] 'Fauna Grœnland.,' pp. 288 and 289.

[4] 'Powers Creator,' vol. ii, p. 147, Pl. XX, figs. 23—25.

[5] 'Zeitschr. f. wiss. Zool.,' Bd. xix, p. 8 (sep. abdr.), Taf. xii, fig. 2*c*.

[6] 'Wissensch. Meersuntersuch.,' Bd. iii, p, 151, Taf. ii, figs. 19—21.

[7] 'Œuvres Diverses,' p. 56.

Leuckart, *Colobranchus ciliatus*, Keferstein, *Uncinia ciliata*, De Quatrefages, and *Scoliolepis vulgaris* (*pro parte*), Malmgren, and moreover approached the *Spio bombyx* of Claparède. The ova of this form, with their pearly specks, were studied by the author, who describes what he calls pre-fecundation. This occurs a short time before maturation, a small mass applying itself to the nucleolus and fusing with it.

The British species of *Spio* range themselves in two groups, viz.: (1) those agreeing with the two species described by Otho Fabricius in having a conical or bluntly-conical snout and two eyes, and (2) those with a bifid snout and two or three pairs of eyes. A more extended examination of this group is necessary, but meanwhile those with the entire snout may for convenience be placed under the old term *Spio*, whilst those with the bifid snout may be distinguished by the title *Euspio*. The imperfection of many of the specimens renders the task of identification difficult, and hence the literature of the group is more or less confused. Talented authors, like Mesnil, have been unable to satisfy themselves as to the precise species described by Fabricius, and much obscurity still remains.

Thus no form subsequently mentioned agrees with the *Spio seticornis* of Fabricius (Die borstenformige Spio) which has a greyish body with pale bands beneath, a conical snout, two eyes, branchiæ from end to end, and two milk-white or pinkish ovate anal cirri.

1. The first is *Spio D*, St. Andrews, which can only be briefly alluded to at present. Plate XCVIII, fig. 8—head; Plate CVI, figs. 8 and 8*a*—stiff, spine-like bristles; Plate CX, fig. 11—capillary bristle.

A fragmentary form, the condition of which is unsuitable for specific characters.

Synonyms.

1862. *Colobranchus ciliatus*, Keferstein. Zeitschr. f. wiss. Zool., Bd. xii, pp. 118—120, Taf. x, figs. 12—18.
1881. *Spio crenaticornis*, Langerhans. Canarische Annel., Nova Acta Acad. Leop.-Carol., Bd. xlii, p. 114. (Eggs red.)
= *Aonis Wagneri*, Leuckart and Pagenstecher. Beitr. Wirbellosen Th., p. 156.
1909. *Spio D*, McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 164.

Habitat.—From the deep-sea fishing boats, St. Andrews, October, 1868 (E. McIntosh).

A softened and fragmentary narrow, elongated form measuring at least two inches in length, and apparently having subulate branchiæ from end to end. The snout appears to be bluntly rounded (but the condition makes even this uncertain) and to have two eyes anteriorly (Plate XCVIII, fig. 8).

The dorsal division of the foot (Plate CVI, fig. 8) has long tufts of very finely tapered capillary bristles, without wings, and posteriorly they increase much in length. The ventral division has a shorter series of stronger bristles with a distinct hook at the point (Plate CVI, fig. 8 *a*), to which the tip curves forward, and some groups consist entirely of these in the pulpy preparation.

2. Spio G. Plate XCVII, fig. 10—tail; Plate C, fig. 12—foot; Plate CV, fig. 12—hook; Plate CVI, fig. 10—bristle.

Specific Characters.—Head rounded in front, forming a bluntly-pointed snout, with the mouth opening a short distance behind the tip ventrally. The two tentacles are of

moderate length, and adhere firmly; an eye is on each side, at the inner base of the tentacle. Body about half an inch in length, somewhat rapidly tapered anteriorly and more gently posteriorly, where it ends with filiform cirri (only one of which is present). Dorsal surface somewhat flattened, ventral rounded. No branchiæ. Dorsal lamellæ much developed and foliaceous in front, especially the third. Winged hooks make their appearance about the fifteenth bristled segment. They are slender, slightly tapered after the backward curve to the throat, have a main fang, and a single spike on the crown. The dorsal lamellæ diminish greatly after the fifteenth segment, and in the posterior half form small conical processes behind the setigerous papilla. The ventral division in the same region is represented only by the hook-papilla. The dorsal bristles are capillary, finely tapered, and curved backward. Posteriorly they greatly increase in length and slenderness.

Synonym.

1909. *Spio G,* McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 165.

Habitat.—From the *débris* of the deep-sea fishing boats, St. Andrews, June 3rd, 1898.

Head simply rounded in front forming a bluntly-pointed snout, with the mouth opening a short distance behind the tip. The two tentacles are of moderate length, and are often gracefully coiled. Moreover, they adhere much more firmly than usual in such forms. An eye occurs in the preparation on each side at the inner base of the tentacle.

The *body* is little more than half an inch in length, rather abruptly diminished anteriorly, and gently tapered to the posterior end, which has two cirri of considerable proportional length, thus differing from *Pygospio*. The dorsal surface in front is somewhat flattened, whilst the ventral is more or less rounded; posteriorly both surfaces are more or less rounded. The bristled segments number about sixty. It is a noteworthy feature that no branchial process has been seen in the preparation, whilst the unusual size of the anterior dorsal lamellæ attracts notice. It may be that in the absence of branchiæ, so rare in the group, foliate organs have a compensatory function.

The first foot has a fairly developed dorsal lamella, which increases in the second, and in the third it forms a large foliaceous expansion. The size of these organs is conspicuous for at least a dozen segments, though they diminish from the fourth backward. The somewhat angular foliaceous flap of the third bristled segment is a feature of much interest, but whether in addition to these the species was furnished with branchiæ could not, from the state of the specimen, be determined. So far as could be observed the dorsal lamellæ between the sixth and twelfth are more or less ovate-lanceolate. The bristles in these anterior segments have the typical arrangement and shape, the upper dorsal are longer; the ventral bristles are shorter and more slender, and the ventral lamella is apparently a short cone.

About the fifteenth segment (Plate C, fig. 12) the dorsal lamella has greatly diminished, though the dorsal and ventral bristles follow the type in front, and winged hooks make their appearance, and continue to the posterior end. The shaft of the hook is slender (Plate CV, fig. 12), has a well-marked backward curve below the wings, tapers a little to the throat, from which the main fang comes off at a right angle, and apparently only one spike occurs on the crown.

The dorsal bristles (Plate CVI, fig. 10), after the fifteenth bristled segment, soon greatly increase in length, the upper especially being long and hair-like, and they become gradually longer in their progress backward, till near the tail, where they are shorter. The dorsal lamellæ throughout the posterior region are small, conical papillæ, which lie behind the setigerous process. The ventral lamella posteriorly is represented only by the papilla for the hooks.

So far as can be observed this form differs from the two species described by O. Fabricius, but approaches an imperfect example of *Prionospio*.

3. Spio filicornis, *O. Fabricius*, 1789 (?). Plate XCVIII, figs. 11 and 11 *a*—head and first foot; Plate XCVII, figs. 9–9 *c*—feet; Plate CV, fig. 13—hook.

Specific Characters.—Head terminating anteriorly in a rounded point—the centre of a cone formed by the buccal segment. A minute black eye on each side of the median ridge, which ends in an occipital papilla or tentacle posteriorly. Body about an inch in length, proportionally short and stout, a little tapered anteriorly and more so posteriorly, where it ends in two broadly ovate cirri. Branchiæ conspicuous from the first foot to the end. Dorsal lamella of first foot elongate-ovoid, with about one-third of dorsal edge free, the rest fused to the base of the branchia, the lower margin trending gently to the body-wall. Dorsal bristles of moderate length, curved upward and slightly backward, finely tapered, the upper series longest and most slender. Ventral lamella is a prominent, obtusely ovate, process. By-and-by the superior lamella is flattened externally and less free superiorly, and the ventral lamella assumes a rhomboidal outline, rounded at the inferior angle. Winged hooks, with a main fang and a spike on the crown, commence in the ventral division about the thirteenth foot, along with the delicate bristles. The lamellæ increase in size before the fiftieth foot, the winged hooks, to the number of nine, occupying nearly the entire length of the ventral lamella.

Synonyms.

1776.	*Nereis filicornis,*	O. F. Müller.	Zool. Danica Prod., p. 218, No. 2640.
1780.	„	„	O. Fabricius. Fauna Grœnland., p. 307, No. 289.
1785.	*Spio*	„	idem. Schrift. Naturf. Freunde Berlin, Bd. vi, p. 264, Tab. v, figs. 8—12.
1791.	„	„	Gmelin. Linn. Syst. Nat., ed. 13, i, p. 3110.
1818.	„	„	Lamarck. Hist. Anim. sans Vert., t. v, p. 319, No. 2.
1820.	„	„	Savigny. Syst. Annel., p, 45.
1828.	„	„	De Blainville. Dict. Sc. nat., t. lvii, p. 441.
„	„	„	Delle Chiaje. Mem., p. 176.
1843.	„	„	Œrsted. Grœnl. Annul. Dorsibr., p. 203.
„	„	„	idem. Annul. Danic. Consp., p. 40.
1844.	„	„	idem. Reg. Mar., p. 68.
„	„	„	idem. Arch. f. Naturges., Bd. x, p. 106.
1851.	„	„	Grube. Fam. Annel., pp. 66 and 134.
„	„	„	Maitland. Fauna Belg., p. 210.
1867.	„	„	Malmgren. Annul. Polych., p. 91, Tab. i, figs. 1—1D^2.
1879.	„	„	Tauber. Annul. Danica, p. 117.
„	„	„	Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 54.

1883. *Spio filicornis,* Levinsen. Nat. For. Vid. Meddel., p. 100.
„ „ „ Wirén. Chætop. 'Vega' Exped., p. 409.
1889. „ „ Marenzeller. Arch. f. Naturges., Bd. lv, p. 132.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 96.
1896. „ „ Mesnil. Bull. sc. Fr. Belg., t. xxix, p. 129.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 152.
1898. „ „ idem. Grœnl. Annel., p. 128.
1909. „ *Gattyi,* McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 165.
„ „ *filicornis,* idem. Ibid., p. 162.
1914. ? „ *martinensis,* Southern. Proc. Roy. Irish Acad., vol. xxxi, No. 47, p. 95.

Habitat.—Swarming in sand near low-water mark, East Sands, St. Andrews. In two fathoms off Symbister Harbour, Whalsay, Shetland.

Head (Plate XCVIII, fig. 11) terminating anteriorly in a rounded point, from which the central ridge passes backward to end in a papilla about the line of the second bristled segment. Two minute black eyes occur (one on each side) in front of the papilla posteriorly. The ridge is supported by the buccal segment, the sides of which are bevelled anteriorly so as to give, from the dorsum, the snout a conical form. The long tapering tentacle comes off on each side just outside the occipital papilla and the eyes.

Body about an inch in length and proportionally stout, a little tapered anteriorly, but more distinctly posteriorly, where it terminates in two broadly ovate cirri. The body acquires its greatest diameter in the preparations just before tapering anteriorly to the snout. Segments distinctly marked, and ranging from 55—65 in number. The gills form a conspicuous feature in lateral view and throughout the whole length, though they are especially so in the anterior half of the body. In the preparations they assume different positions in regard to the vertical axis—now nearly upright, or with a curve forward or backward, and again arched over the dorsum. Their proportional size is noteworthy.

The first foot (Plate XCVIII, fig. 11 *a*) bears a richly ciliated gill of considerable size dorsally, an elongate-ovoid superior lamella with about a third of the dorsal edge free, the rest fused to the base of the branchia, and the ventral margin trending to the body-wall. The dorsal bristles are of moderate length, curved upward and backward, and finely tapered, the upper series, as usual, are the longer and more delicate. The ventral lamella forms a prominent obtusely-ovate process, and the bristles are curved and finely tapered.

The second foot (Plate XCVII, fig. 9) is similar, but the upper lamella is broader, whilst the lower has a tendency to turn upward and to show greater obliquity of its lower margin. The interlamellar gap is deep and broad.

The size of the branchia has increased at the tenth foot (Plate XCVII, fig. 9 *a*), and it is richly ciliated on its inner and posterior borders. The superior lamella is more flattened externally and less free superiorly. The bristles of this division form a dense series, the dorsal curving as usual backward and upward, the rest backward, and to a less degree upward. The ventral lamella has a tendency to a rhomboidal shape, with a rounded inferior angle, and the dense tuft of bristles has its upper forms curved downward at the point and the lower series curved upward.

At the twenty-fifth foot (Plate XCVII, fig. 9 *b*) the upper lamella has diminished from above downward, but still fuses with the base of the branchia. Its upper angle is rounded and points upward, whilst its lower angle is also rounded off as the border runs to the side of the body. The bristles are somewhat longer, and the upper dorsal more slender. The ventral lamella is narrower, with a nearly rectangular upper border, and it has winged hooks (Plate CV, fig. 13), with a few slender tapering bristles. The shaft of the hook dilates upward, bends backward some distance below the wings, slightly dilates, and then tapers somewhat distinctly to the throat, from which the main fang comes off at more than a right angle, and is rather short and sharp, the crown being occupied by a prominent spike. The wings are rather long and of moderate breadth. Three or four of these winged hooks make their appearance about the thirteenth foot amongst the bristles of the ventral division, and they increase to five or six in the fourteenth and fifteenth feet, where a considerable number of the finely-tapered bristles still occur.

The branchia is somewhat less at the fortieth foot, whilst the superior lamella forms a small, bluntly-conical process, its lower border sloping gradually to the body-wall. The superior bristles are all longer and more slender, the dorsal group especially so. The ventral lamella forms a narrow plate, rounded dorsally and ventrally. Six winged hooks form a row with a few slender bristles, whilst inferiorly two thicker curved bristles bend downward. The fiftieth foot (Plate XCVII, fig. 9 *c*) presents a still smaller branchia, but the superior lamella has increased in depth, projecting as a bluntly-clavate flap directed obliquely upward from the base of the branchia, the distal (external) edge being slightly hollowed in the centre. The dorsal bristles exhibit no change. The ventral lamella is also deeper from edge to base, and the upper and lower ends are rounded. A row of nine winged hooks occupies nearly the entire edge, the largest occurring superiorly and the least ventrally in an evenly diminished series, along with a row of very fine, hair-like bristles; whilst ventrally four peculiarly modified curved bristles with slightly hooked points, as in *Spiophanes bombyx*, are situated at the extreme ventral edge of the row, the points being directed downward.

So far as can be ascertained at present, this makes the nearest approach to the *Spio filicornis*[1] of Fabricius. It is true he does not mention the cephalic ridge and its posterior papilla and other particulars, but the form is about the same length, viz. an inch, and in the bluntly-conical snout, eyes, branchiæ, feet, and caudal cirri it agrees.

Spio filicornis is not common, but Malmgren's description is precise.

The *Spio filicornis* of De Quatrefages[2] (1865) is Œrsted's form, not that of Fabricius, and it is difficult to identify it.

The *Spio martinensis* of Mesnil[3] has many points in common with this species, but in others it diverges. The structure of the anal region especially differs, though it must be

[1] O. Fabricius (1780) defines it as *Nereis* with two long thick white tentacles, with dark bands. It is similar to *N. seticornis*, but thicker and shorter—1 inch long and 1 line broad. Tentacles thicker than in the former (*Spio seticornis*) black and white annulated; segments forty-eight, besides head and tail. Longitudinal lateral groove with papillæ, and dorsal cirrus on each segment. Colour greyish; in the middle mixed with red, and with a greyish longitudinal line. The tube is linear, thicker, fragile, of ample length for the animal.

[2] 'Annel.,' t. ii, p. 307.

[3] 'Bull. sc. Fr. et Belg.,' t. xxix, p. 122, pl. vii, figs. 1—20.

noted that Mesnil's drawing (Fig. 20) is not altogether clear; indeed, it might represent a tail in process of regeneration.

Mr. Southern [1] thinks his form agrees with Mesnil's [2] *Spio martinensis*. Between each lateral pair is a patch of pigment formed of small and black grains resembling a third pair of eyes. The ventral hooks are minutely bifid at the tip, and the bristles are frequently covered with a red deposit, which, however, is not to be confounded with the granular or dotted condition of other forms. This annelid needs further investigation. It may be a variety of a known species. It was found at Sandy Mount Strand, Dublin Bay, and in Blacksod Bay.

No example[3] which could be identified with the *Spio seticornis* of O. Fabricius[4] has been met with, but this may be due less to its rarity than to imperfections in the original description. It may be a common form. In order to render the task of identification less difficult the following notes may be added.

Linnæus (1767) considered *S. seticornis* identical with Baster's form (Opusc. subsecira 2, p. 134, Tab. 12, fig. 2).

Œrsted[5] describes *S. seticornis* as from 8—10 lines long, and $\frac{1}{2}$ a line broad; two eyes on each side in parallel series; tentacles tapered at the tip; segments devoid of black points; ligulate branchiæ in the middle of the body, vanishing at each extremity of the series. He thinks that *Spio crenaticornis*, Mont. ('Trans. Linn. Soc.,' vol. xi, p. 14) and *Lumbricus cinatuloides*, D. Chiaje ('Mem.,' Tab. 64, fig. 16) pertain to this genus. He mentions the action of the tentacles from the mouth of the tube capturing small "Naides" and Planarians which the annelid devours. The relationship to the species of Fabricius is uncertain.

De Quatrefages (1865) only quotes this form in his 'Annelés.'[6]

[1] 'Proc. Roy. Irish Acad.,' vol. xxviii, p. 235, 1910.

[2] 'Bull. sc. Fr. et Belg.,' t. xxix, p. 122, pl. vii, figs. 1—20, 1896.

[3] The form described in the 'Annals Nat. Hist.,' ser. 8, vol. iii, p. 163, is still *sub judice*.

[4] O. Fabricius (1780) gives his *Spio seticornis* a length of 3 in., the head broad behind and narrow and rounded in front. Two black eyes on the vertex transversely elongated, having in front of them two soft, long flexible tentacles with thin margins and almost the length of the body. The latter (body) is flattened and grooved dorsally, rounded ventrally; sixty-eight to seventy-six segments, much attenuated posteriorly. Anteriorly in each segment is a cirrus, curved dorsally, pale with a red centre; beneath a papilla bearing several kinds of bristles. Thus the feet are directed dorsally for facility in moving in its tube. Caudal segment with two short ovate cirri, whitish or reddish, sub-membranous. Colour of the body dark in front with whitish segment-junctions, whitish-green with the red dorsal vessel in the middle; posteriorly dull green with the transverse red branchiæ (his cirri). Mouth below the snout, without an extruded proboscis. Tube two-thirds of a line broad, three times as long as narrow, perpendicularly attached above the bottom, composed of secretion, sand-grains and silt (argillaceis), and of the colour of its surroundings—ferruginous or brownish. Eats minute planarians, which it captures with its tentacles. It is not fond of projecting from its tube or leaving it. It sweeps the water with its tentacles, sometimes it projects its mouth—causing a turmoil in the water—probably for food. Rarely it projects from the posterior end of the tube, but it withdraws instantly on vibration of the water.

[5] 'Arch. f. Naturges.,' Bd. x, p. 106, 1844.

[6] T. ii, p. 307.

Strethill Wright,[1] again, minutely described the tentacles of a *Spio seticornis* without indicating what form he meant. Malmgren does not account for this species. The form which Cunningham and Ramage[2] call *Spio seticornis* is mentioned without size, and the distribution of the branchiæ is peculiar, whilst the tip of the tail resembles that of *Pygospio*. Mesnil thinks it has the characters of *Pygospio elegans* of Claparède. Levinsen calls a form *Spio seticornis*, Fabr., because it has winged hooks on the 8th setigerous segment, but he gives no diagnosis of the species.

The *Spio seticornis* of Dalyell[3] (1853) has certain resemblances to a *Polydora*, but its position is uncertain.

The *Spio seticornis* of Benham[4] (1896) may refer to *Pygospio elegans* as well as to the original form.

Mesnil (1897) considers that *Spio seticornis*, Œrsted, is a *Pygospio*, the difference between it and *Pygospio elegans* being the presence of branchiæ in *S. seticornis* on the second segment, and the larger size of the latter species in which the number of segments is sixty. The colour is pale, only a little bluish-green pigment exists on the anterior segments, whilst the prostomial lobe is attenuated and long, and is bifid without the intercalation of a median lobe, and lastly slight differences occur in the tips of the hooks.

Genus XCIX.—Euspio, *n.g.*

Snout with a bluntly bifid median rostrum and a bulging process of the peristomium on each side. Eyes, two or three pairs on each side of the median ridge. Body as in *Spio*, but terminating in two dorsal and two ventral subulate cirri, the dorsal being thicker. Branchiæ from the first foot to the posterior end. Bristles as in *Spio*.

The *Spio lævicornis* of H. Rathke[5] probably belongs to this series, though he figures the frontal tentacles as somewhat longer.

1. Euspio Mesnili[6] (= Spio filicornis, *Malmgren*). Plate XCVIII, fig. 6—tail; Plate XCVI, figs. 7–7*d*—feet; Plate CV, figs. 11–11*b*—bristles and hook, and fig. 16—25th foot.

Specific characters.—Snout somewhat like that of *Polydora* on a large scale and akin to that of *Pygospio*, with a bluntly-bifid median rostrum and a bulging process of the buccal segment on each side. Eyes minute, two or three, on each side of the median ridge posteriorly. The median process passes backward from the tip of the snout and ends in a conical papilla. Body 2—3 inches in length, broad in front, and with scarcely

[1] 'Edinb. New Philos. Journ.,' Oct., 1857, p. 191.

[2] 'Trans. Roy. Soc. Edinb.,' vol. xxxiii, p. 640, Pl. xxxvii, fig. 4.

[3] 'Pow. Creat.,' vol. ii, p. 159, Pl. xx, fig. 22.

[4] 'Camb. Nat. Hist.,' vol. ii, p. 322.

[5] 'Beitr. Faun. der Krym.,' p. 421, Tab. VIII, figs. 1—6.

[6] This agrees with Malmgren's *Spio filicornis*, but not with that of Fabricius. The specific name is in honour of Prof. Mesnil.

visible tapering anteriorly, but gradually diminishing to the moderately slender posterior end which has four cirri, viz. two somewhat longer and thicker cirri dorsally and two shorter and more slender cirri ventrally. Segments from sixty to eighty. The ligulate branchiæ occur in all the bristled segments. Superior lamella of the tenth foot is bluntly rounded dorsally, and slopes obliquely to the wide notch inferiorly. Ventral lamella more or less semicircular. Bristles of the upper division extended, with a longer tuft superiorly, all curved backward and winged. The ventral bristles are somewhat shorter, but similarly tapered, and some of the lower present a slight dilatation in the winged region. The type of foot rapidly changes, for at the fourteenth or sooner, a row of hooks appears in the ventral series, with finely tapered short bristles in front, and a few longer bristles inferiorly. The upper lamella gradually diminishes, and still more the inferior, so that the setigerous process becomes prominent, and a group of bristles at the ventral edge of the inferior division is modified, each being curved and flattened, with a probe-tip or hook. The winged hooks have straight shafts which increase in bulk superiorly, then curve backward and slightly dilate before the constriction at the throat. The strong and sharp main fang comes off nearly at a right angle, and the crown has a single sharp spike in lateral view.

Habitat.—Dredged in 8 fathoms in Bressay Sound, July, 1871.

Abroad it occurs in Greenland (O. Fabricius, Michaelsen), Spitzbergen, Scandinavia (Œrsted), Finmark (Malmgren). Delle Chiaje describes it as rare at Naples.

Head somewhat like that of *Polydora* on a large scale, having a bluntly-bifid median rostrum (prostomium) and a bulging process of the peristomium as a buttress on each side. No eyes are visible in the preparation. The median process passes from the tip of the snout backward, of nearly equal breadth, and ends in a conical papilla.

Body 2—3 inches in length, broad in front, and with scarcely visible tapering anteriorly, whilst it gradually diminishes toward the posterior end, which is moderately slender, the last segment having four cirri, viz. two somewhat longer and thicker cirri dorsally, and two shorter and more slender cirri ventrally, the anus apparently opening between them (Plate XCVIII, fig. 6). The dorsum is somewhat flattened in the broad anterior region, rounded in the narrow posterior part, whilst the ventral surface is flattened, a well-marked median groove passing from the buccal segment to the tail. The bristled segments are distinct and not very numerous, viz. about eighty. The branchiæ are continued from front to rear.

The first foot (Plate XCVI, fig. 7) is comparatively large, with a large and richly ciliated branchia, the broadly lanceolate superior lamella projecting above the level of the dorsum along with the branchia. The tip of the superior lamella is free, whilst the lower margin slopes obliquely to the foot. A tuft of long superior bristles with no traces of wings occurs dorsally, and a comparatively strong series of shorter bristles with curved and finely-tapered tips follows. The ventral lamella is slightly developed as a narrow rounded flap. The setigerous process has a broad fan of bristles similar to the last series.

The large and broad branchiæ form conspicuous organs on the wide anterior region, and at the tenth foot (Plate XCVI, fig. 7 *a*) there is no diminution. The superior lamella is bluntly rounded dorsally, and slopes obliquely to the wide notch inferiorly. It is comparatively narrow. The upper row of bristles is wide, and ends superiorly in the longer

tuft. All show traces of wings, and are curved backward. The ventral lamella is also narrow and more or less semicircular, being rounded dorsally and ventrally. The bristles of this division are, as usual, shorter than those in the upper, and show distinct wings, some of the lower bristles presenting a slight dilatation in the winged region (Plate CV, fig. 11).

This type of foot rapidly changes, for a flattening of the ventral lamella takes place, and at the fourteenth foot, or sooner, a row of hooks makes its appearance with finely-tapered short bristles, a few of the longer bristles remaining at the ventral edge. The upper division and branchia are unchanged.

At the twenty-fifth foot (Plate XCVI, fig. 7 *b* and Plate CV, fig. 16) the branchia is still longer, though somewhat narrower, but the upper lamella has so greatly diminished that the setigerous process in front of it is now prominent, with its upper series of longer bristles and the lower of shorter, the whole forming a gradually diminishing series from above downward. The wings in these are not distinct. The lower end of the upper lamella is visible as a slight incurvation below the bristles, but there is nothing to indicate the commencement of the inferior lamella except the short bristles and hooks. The bristles (Plate CV, fig. 11 *a*) have distinct wings, are arranged at intervals along the row of hooks, and, besides, a group of three at the ventral edge are peculiarly modified as long curved and apparently flattened forms with a probe-tip. The hooks (Plate CV, fig. 11 *b*) have straight shafts which slightly increase in diameter as they rise to the backward curve near the tip, but bending backward they again slightly dilate before the constriction at the throat. The strong and sharp main fang comes off nearly at right angles to the axis of the neck, and on the crown in lateral view is a single sharp spike directed forward and obliquely upward. The wings are well developed, the lower edge being attached to the constriction at the end of the shaft just where the distal dilatation is about to commence.

The branchia is nearly as long at the fiftieth foot, but is narrower, the cuticle and hypoderm having a tendency to form a slight web on the distal half. The upper lamella (Plate XCVI, fig. 7 *c*) forms a triangular web which has a somewhat abrupt border superiorly, but trends downward with a curve to the foot. The setigerous process forms a similar triangular ridge a little within the foregoing lamella, and carries the long tuft superiorly and the diminishing series beneath. Scarcely a trace of the inferior lamella is visible except the row of hooks and bristles. The three modified bristles conclude the series inferiorly.

In the posterior feet (Plate XCVI, fig. 7 *d*) the chief changes are the diminution of the branchia, the prominence of the superior lamella, which has a free ovate-lanceolate tip dorsally, and the elongation of the dorsal bristles, which, however, preserve the same structure. The ventral lamella is distinct, commencing superiorly as a narrow border which curves round the angle to the ventral surface and ceases about the issue of the special group of modified bristles. The hooks are now fewer in number, and issue partly above the ventral angle of the foot and partly below it, the group of specially modified bristles projecting ventralward some distance from the angle. The probe-pointed tip of the latter bristles is often slightly curved. The stout tapering bristles accompanying the hooks are as in front.

Reproduction.—The specimen is a female with small ova.

This form differs from the *Sp. filicornis*, O. Fabricius, as indicated by Œrsted,[1] in its size (8 lines and $\frac{1}{2}$ a line broad), in the two pairs of eyes (Œrsted's being wide in front) in not having the four black points on the last segment (singuli segmenti margine posteriore punctus 4 nigris notato), and in the disappearance of the branchiæ about the middle of the body. Though having four anal cirri, like *Pygospio* it differs in the arrangement of the branchiæ, which, in the species mentioned, commence on the thirteenth segment.

Montagu's[2] (1808) *Spio crenaticornis* is somewhat like *Polydora* without the large bristles in the fifth series, and posteriorly it has two broad, short cirri. It may be allied to *Pygospio*, for minute details in the figures are uncertain. Montagu termed it *crenaticornis* from its crenate tentacles. It had a bifid snout and four eyes. The branchiæ occur from the anterior to the posterior end. Its tubes were attached to Sertularians.

2. Euspio Gravieri,[3] n.s. Plate XCVIII, figs. 5 and 5 *c*—head and tail; Plate C, figs. 4 and 4 *a*—fifth and tenth feet; Plate CV, figs. 8 and 8 *b*—bristles and hook.

Specific Characters.—Head produced anteriorly into a rostrum with two small frontal tentacles, the central region supported by the buccal segment on each side. Median ridge goes backward to the first segment. Tentacles absent in the example. Body about an inch in length, little tapered anteriorly, gradually diminished posteriorly, and ending in two subulate caudal cirri. Branchiæ commence on the first segment and continue apparently to the posterior end. Foot with a narrow and prominent superior lamella in front, and a small conical lower lamella. The former becomes small posteriorly, and the latter flattens out as a narrow rim. The bristles show a long dorsal group, a shorter lower group in the superior division, and a similar short group in the ventral division anteriorly, but at the eighth bristled segment the place of the bristles is taken by winged hooks, the main fang of which comes off at a large angle from the neck, and is not very acutely pointed, the rounded crown bearing a single spike.[4]

Habitat.—Found in a tunnel, probably of *Dodecaceria* or other boring annelid in the spreading form of *Lithothamnion* between tide-marks, St. Peter Port, Guernsey. So far as could be observed no projecting processes or tubes were appended to the tunnel.

The *head* (Plate XCVIII, fig. 5—5 *a*) of this species terminates anteriorly in a rostrum with two short frontal tentacles, and apparently is supported laterally, as in the former species, by a process of the buccal segment. A median ridge continues backward to the first segment, or a little further. The *body* is about an inch in length, very little diminished anteriorly, and in the softened example seems to taper very gradually posteriorly, but the specimen is incomplete. The branchiæ apparently commence on the first foot and continue to the end of the example. They seem to be conspicuous about the middle of the body.

[1] 'Arch. f. Naturges,' Bd. x, p. 106, 1844.

[2] MS. vol., 4to, Linn. Soc., pl. xlix, fig. 1.

[3] Named in honour of M. Charles Gravier, of Paris, who has done so much excellent work in the group.

[4] This, as usual, refers to the lateral view.

This differs from the previous form in so far as the hooks appear before the tenth bristled segment, probably at the eighth. Then at the fifth foot (Plate C, fig. 4) the branchia is well developed, the upper lamella passes outward and upward as a broad conical flap, whilst the bristles (Plate CV, figs. 8 and 8 *a*) form a diminishing series from above downward. The inferior lamella is small, forming a short, blunt cone pointing below the setigerous process, the outline trending thereafter to the body-wall. The curved bristles do not present any feature of note.

At the tenth foot (Plate C, fig. 4 *a*) the branchia is larger and somewhat flattened, the upper free edge of the superior lamella is shorter, and five or six hooks have appeared in the ventral division. These hooks (Plate CV, fig. 8 *b*) have straight shafts increasing in diameter upward, then are curved forward, and again backward just below the wings, whilst the great fang is again thrust forward so as to leave the neck at a large angle, and is thus in contrast with many. No bristles accompany these hooks. The foot-glands are well-developed, occupying fully the lower half of the foot, and are somewhat radiate in arrangement.

At the twenty-fifth foot the branchia is still large, but the superior lamella is small, the bristles retaining the same character as in front. The inferior lamella is also small, and in front of it are three or four hooks—as before, without bristles. The branchia is somewhat less at the fiftieth foot, but the other parts do not offer any noteworthy change. The condition of the specimen, however, as regards the soft parts is unsatisfactory.

Reproduction.—The single example is a female, with numerous and apparently nearly ripe eggs which do not appear to have the rough capsule characteristic of such as *Scolecolepis vulgaris*.

3. ? Spio Atlanticus, *Langerhans*.

A fragment dredged by Dr. Gwyn Jeffreys at a depth of 70 to 80 fathoms in St. Magnus Bay, Shetland, in July, 1867, approaches *Spio atlanticus*, Langerhans, but as the anterior region is imperfect, uncertainty remains. The dorsal bristles are of great tenuity, and the ventral hooks are either broken or rendered indistinct. The posterior dorsal bristles are remarkably long. Certain segments at the anterior end of the fragment (Plate C, fig. 6) showed subulate lamellæ, but whether dorsal or ventral is unknown. The tail is terminated by short cirri, only two of which were distinctly visible. A hook is figured in Plate CV, fig. 14.

Genus XCIX.—Spiophanes, *Grube*, 1860.

Cephalic lobe with two short frontal tentacles and a minute occipital papilla; two palpi, four small eyes in a rectangle, or none. Body vermiform, flattened anteriorly, segments short. Short exsertile proboscis. Posteriorly it terminates in a wide vent with two dorsal and two ventral crenations, the short cirri springing from the ventral pair. Branchiæ absent. Ventral lamella of the foot prominent only in the four anterior

setigerous segments. Feet with dorsal and ventral cirri. Dorsal bristles long, slender, and tapering; ventral bristles abruptly curved backward at the tip. Small winged hooks occur behind the anterior region.[1]

The body-wall in this genus, *e.g.* in *Spiophanes bombyx*, is characterised by the delicate nature of the cuticle, which covers a thick layer of soft and easily abraded glandular hypoderm. Beneath the basement-tissue are dorsally circular muscular fibres, but these are few and indistinct ventrally. The chief feature in the genus is the enormous development of the ventral longitudinal muscles, which in section are about ten times as bulky as the small dorsal which are separated in the middle-line by the arch of the alimentary canal, and have a longer gap than their own transverse diameter between them and the ventral which occupy about half the area of the entire body in section (Fig. 118). These great muscles stretch on each side considerably above the feet to the mid-ventral line where they almost touch, the strand from the alimentary canal and its ventral blood-vessel alone separating them. In transverse section the fasciculi form a

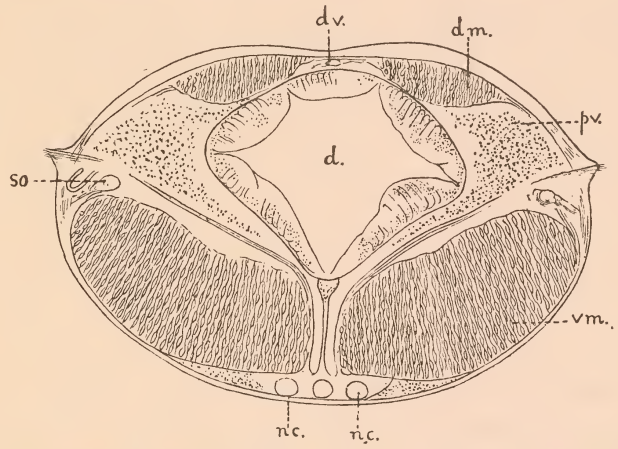

Fig. 118.—Transverse section of the anterior region of *Spiophanes bombyx*, Claparède, in a nearly ripe male.

thread-like series. In the middle line externally are the proportionally large nerve-trunks, distinctly separated in this region by granular neuroglia, and bounded ventrally by the hypoderm and cuticle. The alimentary canal has externally a very thin coating of cœlomic epithelium and circular fibres, and probably a few longitudinal fibres are also present, though they were not clearly differentiated. The mucous lining is thick and often thrown into four folds laterally. The club-shaped granular glands of this coat form a conspicuous feature, and have their broad ends internal.

Grube[2] (1860) found no eyes in his spirit-preparations, but two tentacular cirri on the buccal segment on the dorsal surface. His species (*Spiophanes Kroyeri*) is probably closely allied to *S. bombyx*, the differences being, perhaps, due to imperfections in descriptions. His example came from Greenland.

[1] Short ventral bristles at the fourteenth to fifteenth setigerous segments; the anterior ventral bristles disappearing by-and-by. An inferior ventral bristle is largely developed. Chitinoid fibres (filière) in chambers from the fifth to the fifteenth segments (Mesnil).

[2] 'Arch. f. Naturges.,' Bd. xxvi, p. 88, Taf. v, fig. 1.

1. Spiophanes bombyx, *Claparède*, 1870. Plate XCIII, fig. 1; Plate XCVI, fig. 14—ovum; Plate XCVII, figs. 6—6*d*—feet; Plate XCVIII, figs. 10 and 10 *a*—snout and tail; Plate CV, figs. 9 and 9 *a*—capillary bristles; Plate CVI, fig. 9—dotted bristles; Plate CVII, fig. 16.

Specific Characters.—Head with two short but conspicuous frontal tentacles or palpi, the median ridge running backward therefrom terminating in a small occipital elevation or papilla. Two small eye-specks on each side of the median ridge. Tentacles (tentacular cirri) moderately long. Body about 3 inches long, and having about 180 segments, little tapered anteriorly, and much more so posteriorly, where it terminates in a wide vent with two dorsal and two ventral projections or crenations, the short cirri springing from the ventral pair. Dorsum flattened anteriorly, rounded throughout the rest of its extent, and marked ventrally by a median band, which is forked at the vent and turns upward to join the dorsal band. A median and two lateral brownish lines occur on the dorsum behind the head, but they pass only a short distance backward. Lateral region vascular anteriorly, then brownish, and lastly orange from the colour of the gut. Ventral surface pale, though the gut appears through the wall. The broadly subulate dorsal cirri of several (four) anterior feet carried inward on the dorsum. By-and-by this cirrus shows an enlargement at its ventral base, and such continues more or less throughout. Ventral cirrus conical in front, and soon forms a rounded enlargement in the anterior region, but posteriorly only a border for the winged hooks. Dorsal bristles long, slender and tapering, usually forming a fan-like tuft in front. Ventral bristles abruptly curved backward at the tips in front and dotted distally. Small winged hooks appear at the fifteenth foot, the short, sharp main fang coming off nearly at a right angle from the neck; a single spike (little elevated) on the crown above. Below the row of hooks are one or two strong, tapering curved bristles dotted distally. Peculiar setiparous glands occur in segments five to fourteen. Each gland is large, transparent, and rounded, situated at the base of the foot, and secretes long, flexible thread-like bristles. After the glands cease (fifteenth segment) the bristles of the ventral division are replaced by five to nine minute bifid crotchets (De St. Joseph).

Synonyms.

1870. *Spio bombyx*, Claparède. Mém. Soc. Phys. et Hist. Nat. Genève, t. xx, p. 485, pl. xii, fig. 2 (Suppl. Annèl. Chétop. Neap., p. 121).
1873. ? *Spiophanes cirrata*, Sars. Bidrag Christ. Fauna, p. 68, Tab. xviii, figs. 1—16.
„ „ „ idem. Nyt Mag. f. Naturvid., xix, p. 268, pl. xviii, figs. 1—16.
1875. *Spio bombix*, Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1881. „ *crenaticornis*, Giard. Comp. Rend. Acad. Sc., t. xciii, p. 600.
1883. *Spiophanes Kroyeri*, Levinsen. Nat. For. Vid. Meddel., p. 99.
1885. *Spio bombyx*, Carus. Fauna Medit., p. 255.
1887. „ „ Eisig. Monogr. Capitell., p. 335.
1894. *Spiophanes Kroyeri*, Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 94.
1896. „ *bombyx*, Mesnil. Bull. sc. Fr. et Belg., t. xxix, p. 249, pl. xv.
1897. „ *Kroyeri*, Michaelsen. Polych. deutsch. Meere, p. 154.
„ *Spio bombyx*, idem. Ibid., p. 154.

1898. *Spiophanes bombyx*, De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 352, pl. xx, fig. 165.
1909. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 167.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1914. „ „ Southern, Proc. Roy. Irish Acad., vol xxxi, no. 47, p. 102.

Habitat.—Not uncommon in sand near low-water mark at the East Sands, and near the East Rocks, St. Andrews. Generally encased in a tube of sand. Torquay (Elwes); Blacksod Bay (Southern).

Elsewhere it has been procured in the Mediterranean (Claparède, Panceri); Shores of France (Giard, De St. Joseph, and Mesnil). Mesnil found his examples in rigid tubes of sand near low-water mark, in company with *Echinocardium cordatum* at Wimereux; and Elwes mentions the same at Torquay.

Head (Plate XCVIII, fig. 10) comparatively pale, with two short tapering frontal tentacles, from which a median elevation passes backward to end in a small conical peak or eminence. The two palpi are of moderate size, very frequently coiled, and contain blood-vessels. A small eye-speck occurs on each side of the median ridge posteriorly near the peak, and in the preparations the eyes are raised (with the ridge) above the general level. They are nearer each other than the anterior pair—a little in front.

The *body* is about three inches in length, very little tapered anteriorly, and much more posteriorly, where it ends in a wide vent with crenate lips, two dorsal and two ventral processes being present, the cirri springing from the ventral pair. Many examples show reproduced tails, for the species is remarkable for its fragility, as Mesnil likewise found. The dorsum is somewhat flattened anteriorly, rounded throughout the rest of its extent, and marked ventrally by a median band, which, when it comes to the vent, splits, a limb curving upward on each side and joining the dorsal band, and probably indicating the junction of the ventral with the dorsal vascular trunk. A median and two lateral brownish lines occur on the dorsum behind the head, but they pass only a short distance backward. The sides are vascular anteriorly, then of a pale brownish hue, thereafter orange from the colour of the gut. The vascularity is considerable. The ventral surface is pale, though the gut is seen through the wall. The proboscis forms a short cylinder in protrusion with a slight rim toward the tip, and is apparently smooth.

The œsophagus is dilated behind the head, and has granular glands of a brownish colour. It is contracted between the fifth and sixth bristle-bundles, and proceeds for some distance straight backward. At the fourteenth foot it again dilates a little, and continues to the eighteenth foot, opposite which is a distinct enlargement and a coating of dark green glands. At the termination of the œsophageal region was a blackish mass (of food ?), and this may have caused the dilatation. Under compression the canal has a tesellated aspect, the cells having fatty granules surrounding a central nucleus. Lively movements occur in the canal at the vent, the region being richly ciliated. As in the Oligochæts this region probably aids in respiration.

In the anterior region the dorsal blood-vessel pulsates quietly, driving the blood forward to the transverse vessel behind the eyes, a branch from which enters the tentacle. A conspicuous lateral intestinal vessel extends from the caudal region to the front.

The first foot has dorsally a subulate or narrow lanceolate lamella (cirrus) which has been shifted inward on the dorsum, so that it resembles a branchia. The curved dorsal

bristles are very long and slender, with hair-like tips, and no wings are visible. They spring from an anterior conical setigerous process also carried inward on the dorsum. The ventral bristles of this foot (Plate CV, figs. 9 and 9 *a*) are shorter, but similarly filiform at the tip. In addition there are two much thicker curved bristles with a double outline near the tip, and which resemble modified hooks. They are slightly narrowed at the base (Plate CVII, fig. 16), have nearly cylindrical shafts, then diminish toward the hooked tips, which are strongly curved at a little more than a right angle, and end in a sharp point. The double outline passes downward to the curve. These hook-like bristles evidently perform a special function in its tubicular habits, just as the homologous organs of *Sclerocheilus* do. Either considerable variation occurs, or Mesnil's figure of these organs is at fault, for he shows and describes them as having a simple tapering tip, and winged in the ordinary way, whereas the St. Andrews species has the tip specially differentiated, but there is no wing, though the double outline of the wall of the hook simulates it.

The ventral lamella of the first foot is lanceolate in outline, broader than the dorsal cirrus and less elongated. It ends in a somewhat pointed tip.

The dorsal lamella of the second foot is similar in structure and position to the foregoing, and the bristles are equally long and slender. The ventral lamella forms a shorter conical process, and the bristles though shorter are stronger and have a definite curve backward. Traces of wings also occur.

The dorsal lamella moves gradually to the dorso-lateral region, and the foot at the sixth bristled segment presents a massive lateral enlargement. This is more clearly shown at the tenth foot (Plate XCVII, fig. 6). The dorsal lamella is now considerably shorter, though still subulate, the base is broad, and the bristles can be differentiated into a longer upper series and a shorter and stouter inferior series, as usual in the group, and they spread in a fan-like manner in front of the dorsal lamella. The ventral lamella has been modified into a great lateral mass which passes upward to the base of the dorsal lamella, and contains a cellular structure like a cyst. The ventral bristles are short and stout, the lower forms conspicuously curved backward at the tip, which is minutely dotted or mottled as well as winged (Plate CVI, fig. 9), and is indeed the special bristle figured by Mesnil, so different from the two peculiar hook-like bristles of the ventral division of the first segment. The laterally enlarged feet seem to be most prominent from the fourth to the fourteenth. In its progress backward the dorsal lamella or cirrus becomes less, and presents a ventral enlargement, which is very marked, for instance, at the fifteenth foot (Plate XCVII, fig. 6 *a*), the massive base being in contact with the slender distal process. Moreover, the winged hooks appear in the ventral division of this foot as a row of four, and beneath them is a single, strong curved bristle or two with the dotted or mottled tip pointing downward.

The foot considerably diminishes from the twentieth to the thirtieth. Thus at the twenty-fifth (Plate XCVII, fig. 6 *b*) the form of the dorsal cirrus or lamella is characteristic, its base having the shape of a leg of mutton, with the shank formed by the tapering cirrus. The dorsal bristles are still arranged in a fan-like tuft, the upper being the longer, and a line of powerful cilia runs inward from the foot on the dorsum. The region between the divisions is much reduced, and below the hook two of the powerful bristles with the dotted distal regions occur. They are slightly curved and taper to a sharp point. The

winged hooks are proportionally small, have a slightly curved and sharp main fang coming off nearly at a right angle from the throat, and with a small spike on the crown. At the thirtieth foot at least a dozen of these organs project from the surface. The wings are small. The dorsal bristles have also (at the thirtieth) increased in length, and this feature is marked at the fiftieth foot, where the superior cirrus still retains its characteristic shape. A single tapering strong bristle points downward at the ventral edge of the row of hooks. No branchiæ are present, but powerfully ciliated dorsal bands occur. The lateral region anteriorly has a series of opaque white lobes, almost semicircular in antero-posterior view and situated behind the bristles. They are numerous, but ten from the fourth foot backward are largest and project boldly from the sides. The cirri and the respective bristles occupy their normal position, and the bodies themselves seem to be glandular, containing a globular white sac-like mass, and bundle of fine fibres apparently of secretion, and a cellulio-granular matrix. These glands are probably associated with tube-formation, though no fibroid appearance has been seen in the transparent connecting secretion.

Just in front of the tail (Plate XCVII, fig. 6, and one with a bifid dorsal cirrus in fig. 6 *d*) the dorsal cirrus forms a moderately long subulate organ which occasionally shows a basal enlargement. The long dorsal bristles have a third of their length beyond the tip of the cirrus. The region between the divisions of the foot is convex, and below the row of about seven or eight hooks one or two curved bristles project; the convexity of the curve is outward.

Reproduction.—Specimens procured on June 15th had large ova. A female on May 22nd had the greater part of its body distended with greyish or dull yellow ova, which, when extruded, presented nucleus and nucleolus, and a ring of pale globules round the margin, *i.e.* within the zona (Plate XCVI, fig. 14), the rest of the egg around the nucleus being opaque. The eggs, however, after discharge from the ruptured end, soon alter their appearance and become uniformly opaque, and by-and-by shrivel. Claparède (1870) describes the ova as somewhat flattened spheroids, of 0·13 mm. in longer diameter, with a thick papillose envelope, a germinative vesicle and nucleolus, and a series (twenty) of pale vesicles disposed in a circle, each adhering to the chorion or external envelope.

The young Spionid shown in Plate XCIV, fig. 16, may be that of *Spiophanes*, but those in Plate XCIII, figs. 8 and 9, are more doubtful.

Habits.—In confinement it is an active animal, restless when removed from its friable tube of sand, keeping its flattened snout and two mobile frontal processes in constant motion as it searches the containing vessel. The long tentacles are likewise in active motion, now gracefully coiling in circles, and again extending to their full length. They are irritable and fragile, few specimens being secured entire. Under examination the short proboscis is sometimes thrust out as a wide tube, and again drawn in. It is somewhat delicate in confinement, since its elongated body has generally received injuries more or less severe in capture, yet portions in their tubes survive for a considerable time.

This is one of the many species with which the accomplished Claparède enriched science. The work, both literary and artistic, which this delicate zoologist (for he suffered from hæmoptysis) accomplished under trying circumstances does him infinite credit. He drew special attention to the large pouches containing tough fibres, which he

could compare only with those of *Polyodontes maxillosus*. He considered that it showed more affinities with *Polydora* than with the other Spionidæ.

The *Spiophanes Kroyeri* of Grube [1] (1860) from Greenland is a different form, having a structure anteriorly approaching that of *Prionospio*, at any rate, with four pairs of branchial (?) lamellæ in front.

The *Spiophanes cirrata* of Sars [2] (1873) differs very slightly from this form, the chief characteristics being the presence of more than one spike above the main fang of the hooks, and the equal anal cirri. The British form has the frontal tentacles more distinct, and the cirri seem to be somewhat longer both anteriorly and posteriorly. Much, however, depends on the condition of the specimen and its preparation, and two forms so closely allied need further investigation.

Mesnil (1896) found the pelagic larvæ of this species abundant at Wimereux in August, and it has long been known at St. Andrews. Mesnil recognises them by the absence of black pigment, and the presence of yellowish and orange pigment, especially on the prostomium and perianal ring. In the earlier larvæ of nine or ten segments the snout is smoothly rounded, but when twelve segments are present the frontal processes and tentacles appear, with two pairs of eyes. They are flanked by tufts of long, glistening, provisional bristles, which diminish from before backward. He observed the precursors of the "organes en filières" from the fifth to the eleventh segments. In setigerous segments five to seven is a refringent kidney-shaped mass with two cilia, which the author considers to be the precursor of the glandular pouches or "organes à filière." The anal region has four short appendages.

This author specially alludes to Claparède's "organes en filière" in the adult from the fifth to the fifteenth segment in this species, as composed of minute granular cells which split into thirty chitinous threads, the outer end of which touches the surface between the dorsal and ventral divisions of the foot. He states that they are mobile, after the manner of a brush.

Michel [3] (1898) gives an account of an example which had an oblique bud anteriorly, and five rings were abnormal.

Genus C.—AONIDES, *Claparède*, 1863.

Prostomium forming an acute cone. Branchiæ commencing on the second setigerous segment, and terminating abruptly in the anterior third of the body. Dorsal lamellæ distinguishable from the branchiæ. Anal cirri. Dorsal winged hooks commencing before the ventral.

1. AONIDES OXYCEPHALA, *Sars*, 1861. Plate XCVIII, figs. 9—9 *e*—feet and tail; Plate C, fig. 7—posterior foot; Plate CV, figs. 10—10 *b*—bristles and hook.

Specific Characters.—Head forming an acute cone, the central ridge passing backward to terminate in a small occipital tentacle. Four eyes, two on each side of the ridge in a transverse line just in front of the tentacles. About four inches in length and having

[1] 'Archiv f. Naturges.,' 1860, p. 88, Taf. v, fig. 1.
[2] 'Bidrag Christ. Fauna,' p. 68, Tab. xviii, figs. 1—16.
[3] 'Bull. sc. Fr. Belg.,' 4e sér., t. xxxi, p. 245.

about 200 segments, tapered much anteriorly and also posteriorly, where it ends in a small tail with eight short cirri, the ventral pair being broadly lanceolate. Dorsum flattened anteriorly, rounded posteriorly; ventral surface grooved. Branchiæ conspicuous, confined to segments two to about twenty-three, of a solid, elongated conical form and both edges richly ciliated. Foot with the dorsal lamella firm and large anteriorly, slipper-shaped or somewhat triangular; ventral lobe a broad cone. Both diminish after the branchial region to inconspicuous flaps in the middle of the body, again slightly increasing toward the tail. Dorsal bristles capillary, finely tapered, and similar, but smaller forms occur ventrally. Winged hooks appear in the ventral division about the twenty-fifth or thirty-second foot, and in the dorsal before the fiftieth. They have narrow wings, a main fang, and a spike on the crown.

Colour yellowish or orange, posteriorly brownish.

Synonyms.

1861. *Nerine oxycephala,* Sars. Christ. Vid.-Selsk. Forhandl., p. 64 (sep. cop., p. 15).
1865. „ „ De Quatrefages. Annel., t. ii, p. 663.
1867. *Scolecolepis oxycephala,* Malmgren. Annul. Polych., p. 91.
„ *Nerine* „ idem. Ibid., p. 200.
1871–2. ? *Scolecolepis tenius,* Verrill. Rep. U. S. Comm. Fish and Fisheries, p. 601.
1879. *Scolecolepis oxycephala,* Tauber. Annul. Danica, p. 116.
1883. *Spio oxycephalus,* Levinsen. Vidensk. Meddel. Nat. For., p. 100.
1894. *Scolepis oxycephala,* De St. Joseph. Ann. Sc. nat., 7e ser., t. xvii, p. 81, pl. iv, figs. 101—103.
„ *Spio oxycephalus,* Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 95.
1896. *Aonides oxycephala,* Mesnil. Bull. sc. Fr. et Belg., t. xxix, p. 242, pl. x, fig. 19—28.
1904. „ „ Allen. Journ. M. B. A., n.s., vol. vii, p. 227.
1910. „ „ Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 235.
„ „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1913. ? „ „ Augener. Zool. Anzeiger, Bd. xli, p. 264.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 100.

Habitat.—The largest and finest examples occurred in sand between tide-marks, Lochmaddy, North Uist; in the same region at Guernsey and Herm; coast of Kerry (A. G. Moore); Torquay (Major Elwes); Balscaddon Bay, Howth, Blacksod and Clew Bays (Southern); Berehaven (R. I. A.).

Elsewhere it occurs in Norway in sandy ground (Sars); French coast (De St. Joseph and Mesnil); Franz Joseph Land (Augener).

Head forming a somewhat acute cone, the central ridge from which runs backward to terminate in a small occipital tentacle. The eyes disappear in some preparations, but in others they are very distinct—two on each side arranged in a transverse line just in front of the tentacles, which are of moderate length.

The *body* is about 4 inches or more (Mesnil giving 8 centimetres) in length, characteristically tapered in front to the pointed snout, then enlarging for a considerable distance, and again gently tapering to the tail, the slender tip having short cirri. It is somewhat flattened dorsally in front, rounded throughout the rest of its extent, and deeply grooved ventrally. The mouth opens on the ventral surface a short distance behind the tip of the snout. The grouping of the comparatively large branchiæ on a limited number of segments (twenty-two to twenty-three) anteriorly, especially as this

region is tapered, the comparative smoothness of the enlarged region behind, and the tapering to the minute cirri at the tip of the tail, together with the numerous and narrow segments—about two hundred—are features of moment. Few complete examples are captured, so great is the facility for rupture.

Colour.—Dorsum brownish-yellow, darker than usual in the group, marked by a reddish stripe from the blood-vessel. Ventral surface dull yellow.

The first foot has a small conical dorsal lamella directed obliquely upward, and a series of somewhat short and finely tapered bristles. The ventral division is represented by a small lobe, also conical, and a minute tuft of similar bristles. The second foot shows a larger dorsal lamella, a larger tuft of bristles, the superior being the longer and more slender, and a well-developed branchia. The ventral lamella is small and lanceolate, with a tuft of minute, finely tapered bristles of the usual character. All the parts increase in their progress backward. Thus at the tenth foot (Plate XCVIII, fig. 9 *b*) the branchia forms an elongate massive cone with a double row of strong cilia. The upper lamella is firm and of a broad slipper-shape or irregularly triangular, the point being dorsal and the rounded heel ventral, and it is free from the branchia. A few long slender bristles are uppermost, followed by the row of shorter forms. The ventral lamella is prominent and conical, but the bristles are minute.

The upper lamella is more elongated and more acute superiorly at the twentieth foot (Plate XCVIII, fig. 9 *c*), but the bristles are unchanged, and the inferior lamella forms a prominent cone. The appearance of the winged hooks (Plate CV, fig. 10 *b*) in the ventral division seems to vary. Mesnil found they occurred between the thirty-second and thirty-fifth bristled feet. In the examples from Lochmaddy, North Uist, such was the case, but in those from Herm and Guernsey they appeared at the twenty-fifth bristled segment. These winged hooks by-and-by also occur in the dorsal division (according to Mesnil, from the thirty-fifth to the forty-second), and in those from Lochmaddy behind the fiftieth; the typical appearance in the middle of the body being shown in Plate XCVIII, fig. 9 *d* (Herm). The winged hooks project considerably from the edge of the lamella, and are thus frequently absent from preparations which have been much handled. They are accompanied by the tapering capillary bristles, which do not show wings.

Toward the posterior end the dorsal lamellæ present a slight increase in size (Plate XCVIII, fig. 9 *e*, and Plate C, fig. 7), being of a broadly lanceolate shape, whilst the hooks and bristles, which are often broken, are of considerable strength.

Habits.—An active form, coiling and wriggling in a vessel and forming inextricable knots with its mobile body.

Reproduction.—Female specimens procured in Herm and Guernsey in July and August had numerous ova in the cœlom, some of considerable size.

Mesnil (1896) is inclined to link on Claparède's *Aonides auricularis* to this species, and with reason; and so with the *Scolecolepis tenuis* of Verrill.

Genus CI.—Pygospio, *Claparède*, 1863.

Prostomium without frontal processes. Two long tentacles. Branchiæ commencing a considerable distance backward. Vesicular pouches as in *Polydora*. Four anal cirri.

Winged hooks commencing on the eighth segment. The row anterior to the bristles and the inferior ventral by-and-by disappear. Eggs have no transparent vesicles in the chorion.

1. Pygospio elegans, *Claparède*, 1863. Plate XCIII, fig. 2; Plate XCVI, figs. 9 and 9 *a* —head and tail; Plate XCVII, fig. 8—foot; Plate XCVIII, fig. 14—head; Plate CVI, figs. 1—1 *e*—bristles and hooks.

Specific Characters.—A small form in minute sand-tubes. Head bluntly bifid, with a median ridge running backward to the second segment. Eyes two, four, or six. Tentacles very long and attenuate. Body about an inch in length, with narrow segments (forty to sixty) anteriorly, followed by wider, and the aspect posteriorly is moniliform. Branchiæ commence on the thirteenth segment and continue for twenty, more or less, the superior lamella forming an outer crenate border to the tip. Anteriorly the feet have conical dorsal lamellæ and smaller conical ventral lamellæ, but the latter soon diminish. At the eighth segment the winged hooks appear usually in fours, but posteriorly there are seven. The bristles follow the ordinary arrangement, viz. superiorly longer tapering bristles directed dorsally, and shorter forms beneath in the upper division. They are very slender and much elongated posteriorly. Colour yellowish anteriorly, with a reddish streak from the dural blood-vessel, then the body becomes pale brownish from the gut, the tint fading posteriorly, whilst the four caudal processes are pure white.

Synonyms.

1863. *Pygospio elegans,* Claparède. Beobacht., p. 37, pl. xiv, figs. 27—31.
1865. „ „ De Quatrefages. Annel., t. ii, p. 446.
1884. *Spio Rathburni,* Webster and Benedict. U. S. Comm. Fish and Fisheries, p. 640, fig. 4 (1881).
1888. ? *Spio seticornis,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., xxxiii, p. 640.
1894. *Pygospio minutus,* Giard. C. R. Soc. Biol., 10e sér., i, p. 246.
1896. „ *elegans,* Mesnil. Bull. sc. Fr. et Belg., t. xxix, p. 175, pl. xi, fig. 1—17.
1909. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 166.
1910. „ „ Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 232.

Habitat.—Abundant in sandy tubes in fissures of the East Rocks, St. Andrews; in muddy cracks of the rocks, between tide-marks, and by splitting the rocks near the mouth of the harbour, St. Peter Port, Guernsey; in sandy tubes amongst the rocks, Cobo Bay, Guernsey; and in similar tubes at White Cliff Bay, Isle of Wight (A. M., R. M., and W. C. M.); Howth (Southern); Granton, Firth of North (Cunningham and Ramage).

Coast of Normandy (Claparède). Shores of the Channel, along with *Polydora ciliata* and *Fabricia* (Giard and Mesnil). Virginia? (Webster and Benedict).

A minute form, in which the snout is slightly bifid and somewhat expanded in front, the median process or ridge being continued backward and ending bluntly between the first and second segments (Plate XCVI, fig. 9, and Plate XCVIII, fig. 14). The eyes vary in number, for occasionally only a single pair are present on the ridge about the middle, whilst in others there are three pairs of small black eyes situated behind the middle of the ridge and between the tentacles, and it may be with a seventh speck on one side posteriorly. In a few instances two eyes occur on one side and three on the other. On

each side the central process is supported by the buccal expansions and the first segment. The mouth opens on the ventral surface just behind the anterior border, and has a lip at each side.

The body is about 15 or more mm. in length, of a dull yellowish colour, with a tint of orange, the anterior third being reddish from the blood-vessels. Segments forty to sixty. Twelve bristled segments anteriorly have only the lamellæ projecting dorsally, the thirteenth[1] bearing a well-marked branchia to the outer border of which the somewhat crenate lamella is fused (Plate XCIII, fig. 2). Moreover, these segments are narrower than the succeeding. From nineteen to twenty-five pairs of branchiæ are largely developed, with conspicuous cilia, in a row along the median anterior region (Mesnil says internally), and the branchiæ of opposite sides have their ciliated rows connected by an intermediate line of these organs. The longest branchiæ are about the posterior third of the series. Mesnil describes the French examples as having generally about eight pairs, though they may reach the number of twenty-three, so that the British representatives appear as a rule to have more than the French, in which Mesnil further states that the branchiæ are equally developed throughout. Posteriorly the body terminates in four small whitish conical processes (Plate XCVI, fig. 9 *a*), which are not ciliated.

The first foot springs from the side immediately behind the base of the palpus, and bears superiorly an acutely-conical lobe behind the blunt cone of the setigerous process. The bristles are capillary, finely tapered, and arranged in the typical manner, the longer forms being dorsal. The ventral lamella is also conical, and the setigerous process carries similar bristles, which increase in length in the second foot, and at the fourth the ventral lamella is obtuse, whilst the dorsal is less acute. The upper dorsal bristles are long and finely tapered (Plate CVI, figs. 1 and 1 *c*), whilst the lower and shorter have broader tips with finely attenuate ends (Plate CVI, figs. 1 *b* and 1 *c*). All the bristles are dotted, curve backward, and the wider inferior forms occur in the third foot as indicated by Mesnil.

This type of foot goes as far as the seventh, the eighth having its ventral bristles replaced by winged hooks (Plate CVI, figs. 1 *d* and 1 *e*), about four of which occur in each foot. The wings are broad and short, expanded, and smoothly rounded distally, and the shaft has distally a forward curve, then below the wings it bends backward, and only very slightly diminishes from the throat, from which a short sharp main fang passes off at a little more than a right angle, and with a single prominent spike on the crown.

The tenth foot has dorsally a small conical dorsal lamella with a tuft of long, slender bristles, the upper (and posterior, Mesnil) being the longer and directed obliquely upward and outward. There is little to indicate the ventral lamella except a short and very narrow rim, where the four or, occasionally, five winged hooks emerge.

The thirteenth foot (Plate XCVII, fig. 8) ushers in a change, for the dorsal lamella now forms an external border to the branchia, a few crenations occurring along its free rim, and a blood-vessel internally forming a loop at the tip and returning. The bluntly-conical setigerous process has four longer and more slender tapering bristles directed upward and outward, followed by the shorter series with very narrow wings. The outline of the foot passes downward with a slight curve outward and then inward toward the row of four winged hooks, the fangs of which point upward. A slight elevation

[1] Mesnil has found them on the eleventh.

above the hooks, and another toward the ventral edge of the row, with a depression between, probably indicate the ventral lamella.

In transverse section the anterior region agrees with the type of the Spionidæ. The dorsal longitudinal muscles taper toward the middle line, and at first the ventral longitudinal are lateral in position, a wide interval with transverse fibres internally occurring between them. Vertical fibres pass, as in other forms, from the dorsal to the ventral margin, and a group of longitudinal fibres occurs on each side of the middle line within the circular (transverse). The nerve-cords are at first wide apart in the hypoderm, but they by-and-by come together in the mid-ventral line, and a neural canal occurs between them in the anterior region. After the disappearance of the cephalic dorsal keel, the

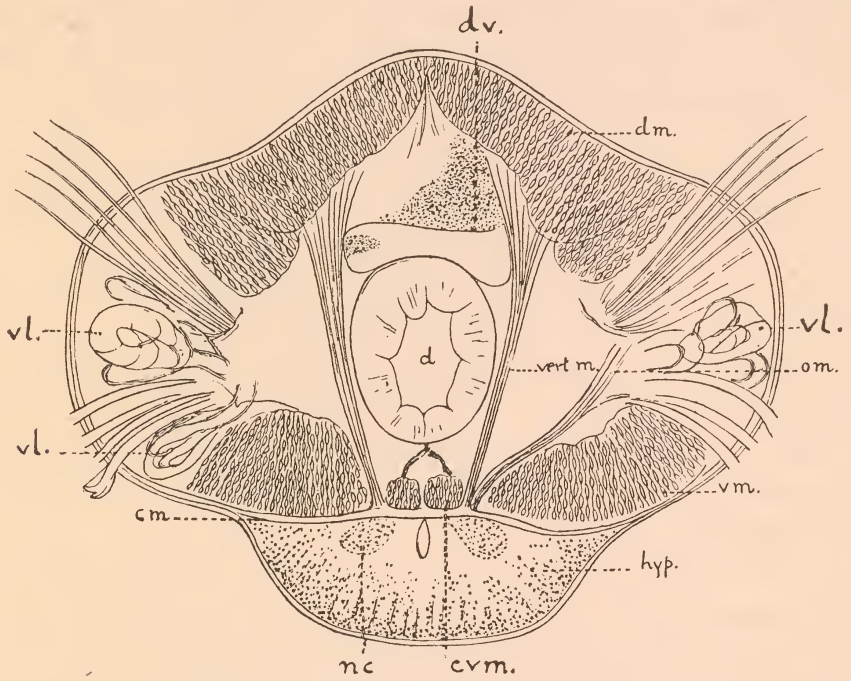

Fig. 119.—Transverse section of the anterior region of *Pygospio elegans*, Claparède. Enlarged.

mid-ventral region becomes prominent by the increase of the hypoderm (Fig. 119, *hyp.*), which forms a thick layer outside the nerve-trunks. In this region transverse fibres still bound the nerve-cords internally, and on the inner surface of these are the special longitudinal fibres, between which and the longitudinal ventral muscles the vertical fibres from the dorsum pass for insertion.

The twenty-fifth foot presents a branchia as large as in front, with a broad, frilled lamella externally. The dorsal setigerous process is a small conical papilla, from which longer and more slender winged bristles than in front project. Four or five winged hooks occur ventrally. Each foot has a series of glands forming a rounded mass with refringent contents.

Posteriorly the dorsal bristles greatly increase in length and slenderness, stretching upward and outward as a hair-like tuft, whilst the superior lamella is represented by a small conical papilla above their base. A slight rim indicates the ventral lamella, and the hooks occupy the same relative position, but their number is greater, viz. about seven.

Numerous clavate (thecate) Infusoria occur on the dorsum and on the branchiæ, whilst in the intestine are many Gregarines.

Habits.—This species occupies a tube of dense, translucent, chitinous material coated with sand-grains, and it is interesting to note how neatly the black grains, for instance in those from White Cliff Bay, Isle of Wight, are intermingled at intervals with the pale grains. In those from Cobo Bay, Guernsey, fragments of shells are largely used with the sand-grains. At St. Andrews the sandy tubes in the fissures of the rocks occur in association in considerable numbers. When placed in a vessel of sea-water little is seen of the inhabitants, which are somewhat shy. By-and-by, when all is still, two slender filaments like hairs (the tentacles) are protruded, and they make extraordinary movements, coiling, wriggling, and twisting most actively, and yet with a definite purpose, for grains of sand and particles of various kinds are drawn or mysteriously passed to the mouth of the tube to repair damages or lengthen it. These mobile sensitive filaments stretch a long distance and grasp and pull particles toward the aperture. A minute red streak along their centre indicates the vascular supply. When removed from its tube it is an active and restless form, lashing its tentacles in the water, and coiling or bending its body in ceaseless movements. Occasionally an injured animal will remain at rest for a short time, but this seldom occurs in a free uninjured one.

This was one of the forms which the acuteness of Claparède (1863) rescued from the confusion of forms associated with *Spio*.

Pygospio seticornis, Œrsted (non Fabr.), Mesnil[1] thinks is Cunningham and Ramage's species in 'Trans. Roy. Soc. Edinb.'

Mesnil (1896) found irregular segmentation in one example, the fifth left corresponding to the fifth and sixth segments on the right, and occasionally the winged hooks do not occur till the ninth segment.

Genus CII.—Polydora, *Bosc*, 1802.[2]

Prostomium generally bifid, though occasionally rounded in front, and from this a prominent ridge passes backward for a few segments. Eyes two pairs, or absent. Peristomium projects at the sides and in front, and bears two long tentacles, each with a papillose and ciliated groove, and the mouth forms a V-shaped aperture ventrally with two prominent rounded lips. Body generally translucent, of small size, conformable to that in the Spionidæ; segments numerous, reaching 200 or more, generally furnished with double groups of bristles dorsally and ventrally in front, but about the seventh the ventral division bears winged hooks. Anterior region of few segments. Branchiæ generally begin after the sixth bristled segment (except in one form), and they vary in number. The fifth bristled segment is of great length, has dorsal and ventral capillary bristles, but also highly modified large hook-like bristles accompanied by lancet-like forms, and the ordinary hooks appear on the sixth or seventh segment and continue to the posterior end. Body terminates posteriorly in a cup-like caudal appendage or funnel.

[1] 'Bull. sc. Fr. Belg.,' xxx, p. 85, 1897.

[2] 'Hist. nat. des Vers,' i, p. 150, Paris, an x.

Feet biramous, with dorsal and ventral bristles anteriorly, dorsal bristles and ventral hooks posteriorly.

In *Polydora ciliata* the body-wall anteriorly is characterised by the great development and bifid nature of the median ridge of cuticle, hypoderm, and muscular fibres, which is flanked on each side by a prominent process of the hypoderm. In transverse section of the snout a little behind the tip, there is on each side of the dorsal process a large rounded (lappet-like) lobe which extends downward to the oral aperture. Externally is the cuticle, then a thick layer of hypoderm, having internally a series of circular fibres, which come from the dorsal arch in the form of a loop at each side and pass to the ventral border, curve inward and then proceed upward over the pharynx to its dorsal region. A well-marked series of longitudinal fibres lines the outer division of the loop (Fig. 120) in the form of fasciculi, and subsequently each merges into the ventral longitudinal muscle of the side. These longitudinal fibres abut on the cœlom. Then the section presents a kind of X-shaped central region, the tips of the X being prolonged horizontally so that

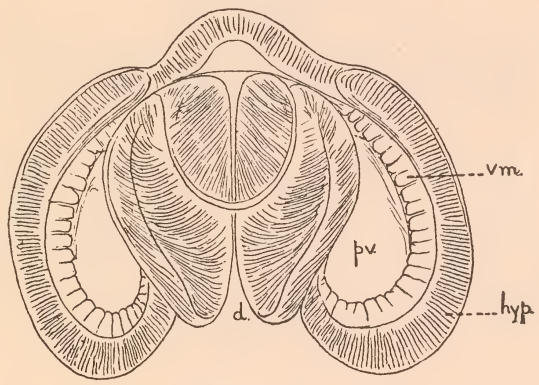

Fig. 120.—Transverse section through the mouth of *Polydora ciliata*, Johnston.

the whole section resembles a figure of ∞, the lateral cœlomic spaces being sheathed in muscular fibres. The dorsal arch of transverse fibres cuts off the nerve-ganglia in the hypodermic process, and in the space which forms therein is a small group of longitudinal fibres.

Behind the foregoing a transverse dorsal layer (part of the circular) is found beneath the central and now solid hypodermic process (Fig. 121) next the dorsal longitudinal muscles, the fasciculi of which, in the middle line, are directed downward and outward, whilst the outer are directed downward and inward. The pharynx forms about a third of the area in section as a large organ with folded walls, numerous blood-vessels on each side, and supported by strong bands of muscular fibres chiefly vertical in direction. The longitudinal, ventral, and oblique muscles are now largely developed, each of the oblique having the nerve-cord below its ventral attachment, and they are still widely separated. The upper lateral regions have the feet with their bristles, branchiæ, lateral lamellæ, and numerous blood-vessels.

The fifth bristled segment bears the remarkable hooks characteristic of the genus, besides bristles with spear-shaped tips and minute fascicles of the ordinary structure. Immediately in front of the hooks the body-wall externally has beneath the hypoderm a circular muscular coat, which is thin at some parts but greatly developed at others. Dorsally

a powerful series of fibres spreads outward from the middle line on each side, some becoming continuous with the circular coat, others passing obliquely outward and downward to the superior bristle-bundle. Inferiorly a strong band lies over the nerve-trunks, and forms an external investment to the ventral longitudinal muscles. The oblique muscle comes from the lower bristle-bundle, and joins the circular over the nerve-trunks

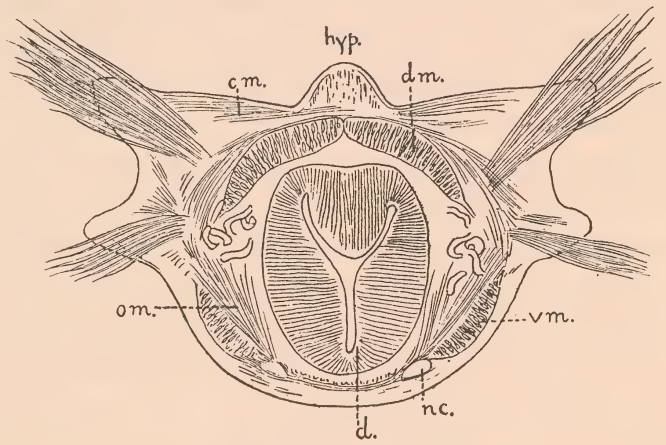

Fig. 121.—Transverse section behind the snout of *Polydora ciliata*, Johnston, showing the massive proboscis and the separate nerve-cords.

after passing the vertical bands. The dorsal longitudinal muscle forms a great mass at each side, and the fibres of the vertical muscles interdigitate with it, and these are greatly developed at the sides of the œsophagus. The same muscles traverse the ventral longitudinal muscles in the compartments formed for them by the circular and oblique bands. The size of the ventral is less than that of the dorsal longitudinal muscles. A somewhat

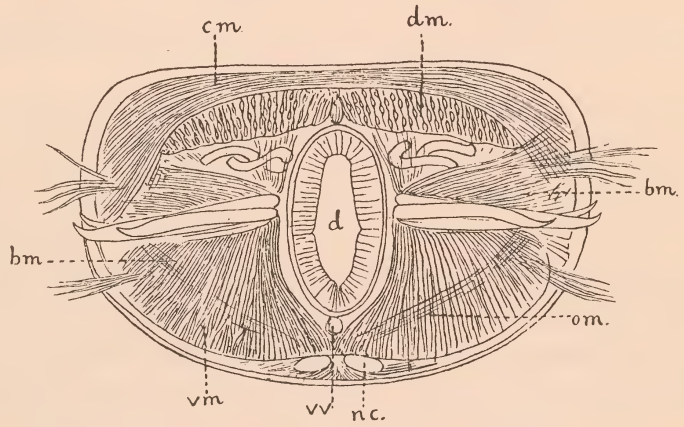

Fig. 122.—Transverse section of the body-wall through the fifth segment of *Polydora ciliata*, Johnst. *bm.* Muscles of the bristles.

strong group of longitudinal fibres lies within the ventral transverse band. Each fascicle of the ordinary bristles has a **V**-shaped series of fibres extending from the base of the tuft to the lateral wall, and interdigitating with those from the transverse and other muscles of the region.

As soon as the powerful hooks of the fifth segment appear, the central area, from the alimentary canal to the body-wall, is occupied by their muscular apparatus (Fig. 122, *bm.*). The median hypodermic ridge of the dorsum ceases with the previous segment. Dorsally the fifth segment is flattened and rounded at the upper angle, and it has above

and below the great hooks a small tuft of capillary bristles with winged tips. The body-wall slopes from the upper lateral region to the convex ventral surface. In the centre is the alimentary canal with a powerful series of vertical fibres on each side stretching from the dorsal to the ventral wall. A dense mass of fibres radiates, from the base of the powerful bristles superiorly, upward and outward to decussate with the circular fibres at the outer and upper angle of the body-wall. A still stronger series of fibres radiates ventrally to interdigitate with the ventral longitudinal muscle of each side, and are fixed to the basement tissue of the hypoderm, the inner being nearly vertical, the rest sloping downward and outward, and, in connection with this preponderance of the ventral series, it has to be noted that the curve of the tip of each hook is directed upward. A group of longitudinal fibres is separated from the ventral longitudinal muscle on each side by the strong vertical fibres adjoining the alimentary canal, and passing for insertion into the basement-tissue of the ventral edge. The oblique muscles stretch from the lower border of the setigerous region to the ventral median line, thus crossing in their progress the

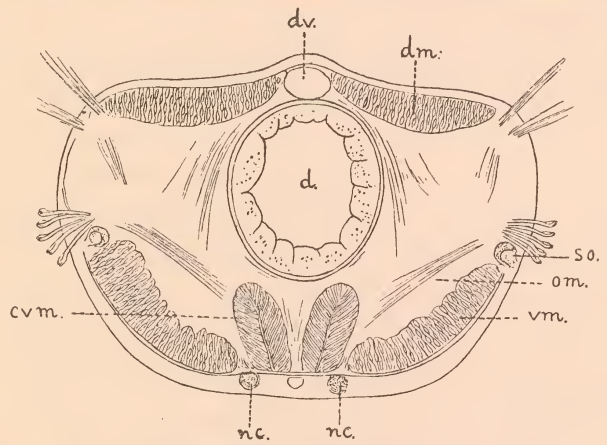

Fig. 123.—Transverse section of the posterior region of *Polydora ciliata*, Johnston, showing the pennate condition of the central muscles, *cvm*, of the ventral longitudinal series.

vertical fibres just alluded to. Beneath the insertion of the oblique is the nerve-trunk of each side lying in a thickened area of hypoderm.

In the posterior region (Fig. 123) the dorsal longitudinal muscles are less developed than the ventral, which move further outward, the median ventral region being occupied by two separate pennate muscles, *cvm.* (in transverse section), which form a V below the alimentary canal. These special muscular slips are characteristic of this form, and they extend throughout a considerable region of the body behind the front. A single large neural canal exists at the upper region in the middle of the fused cords.

The genus *Polydora* was first clearly described by Claparède[1] (1861), who, however, placed it under the family Ariciidæ partly because no jaws were present. In this account he distinctly outlines all the salient features of Bosc's genus hitherto imperfectly known and described. He compared a *Polydora* he procured in the Hebrides with that of Bosc from Charleston, in the United States, and appears to agree with the older author in considering that the caudal process was used as a sucker. He again refers to the group in his 'Beobach. Anat. u. Entwickel.'[2]

[1] 'Recherches Anat.,' p. 47; see also 'Archiv f. Anat. u. Physiol.,' Bd. iii, p. 542.

[2] Pp. 36 and 37.

The Polydorids are a brittle group, throwing off their long tentacles, and readily rupturing the body.

They perforate shells and rocks of various kinds.

Inhabit tubes of sand or burrows in rocks and shells.

Martin Slabber[1] (1778) gives a figure of "*Scolopendra marina*" which is evidently a *Polydora*, probably the common species, though the differentiation of the fifth segment and other parts is not alluded to. The cilia on the branchiæ, the posterior funnel, and the capillary dorsal bristles are indicated.

The *Spio seticornis* of De Blainville[2] (1828) is represented on Plate XIX, fig. 2, and so far as can be observed it is a *Polydora* with four bristled segments in front of the fifth with its great crotchets. He placed *Spio* and *Polydora* with *Pectinara* and the Serpulids under his first order, Heterocriciens.

Cuvier (1817) appears to have confounded this form with *Spio*, for he figures the anterior region of *Polydora* as that of *Spio seticornis*, though he describes the genus *Spio* as different from the *Polydora* of Bosc.

Audouin and Milne Edwards (1834) thought that *Polydora* might be placed amongst the Nereidiens, and that in general form it approached *Peripatus*. They do not allude to its tentacles.

Œrsted[3] followed Johnston in giving the name *Leucodorum* to the genus, which he placed under his Ariiciæ naidinæ, a sub-division of the Ariiciæ veræ. He mentions two species—*L. ciliatum*, Johnston, and *L. cœcum*, Œrsted.[4]

M. de Blainville thought Baster's figure (Opuse. subs. II, LIV, III, Plate XII, fig. 2) had a resemblance to that observed by Suriray, and represented in the "Atlas du dictionnaire" under the name *Spio seticornis* (Plate XIX, fig. 2). It appears to be *Polydora*. Slabber's *Scolopendra marina* is similar.

De Quatrefages[5] (1850) observes that in *Polydora* the ventral vessel is single throughout the greater part of its extent, but in front it bifurcates, and the three anterior rings have a double vessel. The dorsal trunk presents an inverse arrangement, for it is single in the four anterior segments, then bifurcates and forms the ventral trunks. The dorsal and the ventral trunks are joined by large connecting branches. The branchiæ have a central canal and lateral lacunæ, with cilia on the surface, and De Blainville thought that the tentacles were also respiratory, their canal communicating with the general cavity of the body.[6]

The *Nereis contorta* of Dalyell[7] (1853) may be a *Polydora* to judge from the sucker-like posterior extremity, but he mentions no differentiation of the fifth segment. Of the Spionids he observes that one is extremely rare, and the other so minute as readily to escape observation. It is otherwise now. It is possible that his *Spio seticornis* may be *Pygospio*.

[1] 'Naturkundige Verlustigungen,' Haarleim.

[2] 'Dict. Sc. nat.,' t. lvii, p. 441.

[3] 'Arch. f. Naturges.,' Bd. x, p. 105, 1844.

[4] Mr. Southern records *Polydora cœca* as common on the west coast of Ireland. 'Proc. Roy. Irish Acad.,' vol. xxxi, no. 47, p. 103, 1914.

[5] 'Ann. Sc. nat.,' 3e sér., t. xiv, p. 282.

[6] *Ibid.*, p. 293.

[7] 'Pow. Creat.,' vol. ii, p. 156, pl. xx, figs. 19 and 20.

Alex. Agassiz (1866)[1] describes the young stages of a species which he identifies with *Polydora ciliata*, Johnston, but there exists doubt as to its specific relationships. His earliest stage shows short tentacles, twelve bristled segments, and three crotchets in the fifth, and his latest is nearly adult in character. He also makes remarks about *Leucodora*, Johnston, as if the genus could be separated from *Polydora*, Bosc. His figures generally are excellent, though the minute structure of the distinctive bristles is not given with such detail as to ensure accurate diagnosis. He found the adults in tubes amongst mud between tide-marks, and mentions that the larvæ are easily reared to the stage of tube-formation. He specially alludes to the lateral glands in the posterior region (behind the great crotchets of the fifth segment).

Claparède (1868) took note of the glandular pouches which are highly developed in segments seven to ten of *Polydora Agassizii* (a form closely allied to *P. ciliata*); and the flask-shaped cells of which are so characteristic. He also describes the segmental organs as folded ciliated tubes with an internal and external opening, and which in the sexual region at maturity undergo considerable enlargement.

Claparède and Mecznikow (1868) describe and figure a larva of *Polydora* of a pyriform outline and about a dozen bristled segments, the fifth having its special bristles. It is a telotroch larva with a protrotroch in front, and the anterior region is speckled with brownish pigment.

Ray Lankester (1868)[2] thought that the boring of *Polydora* and other forms was due to an acid, but while it is true that boring occurs very extensively in calcareous rocks, yet it also occurs in sandstone and shale impermeable to an acid, and consequently this theory was withdrawn shortly afterwards.

Prof. Haswell[3] (1880) makes some noteworthy remarks on the perforation of Australian oysters by a *Polydora* resembling *P. ciliata*, and gives a description of a new species.

Carazzi (1893) gave a careful historical account of the genus, instituting a new sub-genus (*Boccardia*) for Haswell's *Polydora polybranchia*—the branchiæ in which begin on the second setigerous segment, and the hooks of two kinds on the fifth—and besides referring to the species of *Polydora* then known, added a variety (*pulchra*) of *P. antennata*, Claparède. His second sub-genus is distinguished from the first (*Boccardia*) by the branchiæ commencing on the sixth setigerous segment, and by the hooks on the fifth being of one kind.

One of the most complete accounts of the genus and species is that of Mesnil (1896), and he gives a tabular view of the characters by which each form can be recognised. If anything, this able author makes, perhaps, too much of slight distinctions, and thus inclines to increase the number of species. He also gives a comparative series of the pygidia of the several species. He was of opinion that the large modified bristles of the fifth segment perforate hard rocks.

Benham[4] (1896) made a separate family for *Polydora* (Polydoridæ) mainly on account of the special armature of the fifth segment, but this is on the whole unnecessary.

[1] 'Ann. Lyceum Nat. Hist. N. York,' vol. viii, p. 323.

[2] 'Ann. Nat. Hist.,' ser. 4, vol. i, p. 234.

[3] 'Jottings from the Biol. Laborat. of Sydney University,' p. 274.

[4] *Op. cit.*, p. 323.

In an interesting paper, Prof. Salensky [1] (1908) gives a description of the œsophageal pouches of *Polydora cornuta*, *Spio fuliginosus*, etc., which he was led to examine from his previous researches on *Polygordius* and *Saccocirrus*. In *Polydora cornuta* these are five in number and well developed, though temporary (larval). He broaches the view that these may represent the gill-slits of the Chordates and Enteropneusta.

Polydora is a persistent borer in shells, aluminous shale, sandstone and other rocks, and it especially frequents the valves of the oyster on every coast.[2] Mr. Crossland found in the Red Sea that it inserted itself between the mantle and the large pearl shell, where it accumulates mud in considerable quantity and makes it unsightly, the worm and the mud being covered by a thin secretion of nacre. He thinks that it thus evades the trouble of boring, but this is doubtful. M. Leon Vaillant,[3] again, uses the boring region of *Polydora* in calcareous rocks as a limit. Where granite occurs they do not bore (De St. Joseph).

Polydora ciliata. Plate LXXXIX, fig. 4; Plate XCIII, figs. 6 and 7—young; Plate XCVII, fig. 7—Infusorian parasite; Plate XCVIII, fig. 15—tail; Plate XCIX, figs. 1 and 1 *a*—tubes and tentacles; Plate CVI, figs. 2—2 *d*—bristle and hooks.

Specific Characters.—Head with the prostomium elevated and terminating anteriorly in two rounded lobes with a median notch, and the ridge passes backward to the third segment. Dark pigment at the sides of the ridge and in the furrows of the first four segments. Four black eyes on the ridge. Body largest in the anterior third, flattened dorsally and rounded ventrally, tapered a little anteriorly and more distinctly posteriorly, where it ends in a cup-like process with diminished margins trending to a dorsal notch. Segments from sixty to seventy-five. Colour yellowish-brown or straw-yellow, with the red median dorsal vessel. Branchiæ commence on the seventh foot and extend to the thirty-eighth, though the number varies. First foot with a dorsal lamella without bristles, but the latter occur throughout the rest of the body. The fifth bristled segment has large hook-like bristles, the tips being curved, more or less acute, and having a small spur on the neck. They are directed backward or upward.

Synonyms.

1778. *Scolopendra marina,* Slabber. Naturkund. Verlustig., p. 51, pl. vii, figs. 1 and 2.
1781. *Insecte destructeur des pierres,* Dicquemare. Obs. sur la Physique, t. xviii, pp. 222—224, pl. ii.
1802. *Polydora cornuta,* Bosc. Vers, i, p. 150, t. iii, figs. 7—8.
1815? „ „ Oken. Lehrbuch, iii Theil, ii Bd., p. 374.
1827? *Spio caudatus,* Delle Chiaje. Mem., vol. ii, p. 426, Taf. xxviii, fig. 10.
1828. *Spio seticornis,* Blainville. Dict. Sc. nat., Vers, t. lvii, pl. xix.
1836. „ *calcarea,* Templeton. Loud. Mag. Nat. Hist., vol. ix, p. 234, fig. 27.
„ *Diplotus sp.*? Garner. Trans. Zool. Soc., vol. ii, p. 95.
1838. *Leucodore ciliatus,* Johnston. Mag. Zool. and Bot., ii, p. 67, pl. iii, figs. 1—6.

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[1] 'Bull. Acad. Impér. St. Pétersburg,' pp. 687—708, with text-figs.

[2] *Vide* "On the Boring of Certain Annelids," 'Ann. Nat. Hist.,' Oct., 1868, pp. 276—295, pls. xviii, xix, and xx; and "On the Boring of *Polydora* in Australian Oysters," *Idem*, April, 1902, p. 308.

[3] 'Ann. Sc. nat.,' 7e sér., t. xii, pp. 39—50, 1891.

1843. *Leucodorum ciliatum,* Œrsted. Annul. Dan. Consp., p. 39.
1844. „ „ idem. Arch. f. Naturges., Bd. x, p. 105.
1849 ? „ *muticum,* Leuckart. Ibid., Bd. xv, p. 200, Tab. iii, figs. 12*a*—12*d*.
1851. *Leucodore ciliata,* Grube. Fam. Annel., pp. 67 and 134.
„ „ *mutica,* idem. Ibid., pp. 67 and 134.
„ „ *ciliatus,* Williams. Rep. Brit. Assoc. for 1850, p. 208, fig. 18.
1853. *Leucodorum ciliatum,* Sars. Nyt Mag. f. Naturvid., vol. vii.
„ ? *Spio colata,* Dalyell. Pow. Creator, vol. ii, p. 160, pl. xx, fig. 21.
„ ? „ *seticornis,* idem. Ibid., p. 159, pl. xx, figs. 19—20.
1855. *Leucodore ciliata,* Grube. Arch. f. Naturges., Bd. xxi, p. 107.
„ „ „ var. *minuta,* idem. Ibid., Bd. xxi, p. 107.
1861. *Polydora sp.*? Claparède. Mém. Soc. Phys. et Nat. Hist. Genève, t. xvi, p. 115.
„ „ *cornuta,* idem. Archiv f. Anat. u Physiol., Bd. iii, p. 542.
1862. *Leucodore ciliata,* Keferstein. Zeitschr. f. wiss. Zool., Bd. xii, p. 116, Tab. x, figs. 1—11.
„ *Polydora ciliatum,* A. Agassiz. Journ. Boston Soc. Nat. Hist., vii, pp. 384—419.
1863. *Polydora sp.*? Claparède. Beob. Anat. Entw., pp. 36 and 69, Tab. 7 and 8.
1865. *Leucodora ciliata,* Mecznikow. Zeitschr. f. wiss. Zool., Bd. xv, p. 338.
„ *Leucodore ciliatus,* Johnston. Cat. Worms Brit. Mus., p. 205, pl. xviii, figs. 1—6.
„ ? *Polydora cornuta,* De Quatrefages. Annel., t. ii, p. 205.
„ *Leucodore audax,* idem. Ibid., p. 298.
„ „ *ciliatus,* idem. Ibid., p. 300.
„ „ *dubius,* idem. Ibid., p. 301.
„ „ *muticus,* idem. Ibid., p. 308.
„ ? „ *Fabricii,* idem. Ibid., p. 300.
1867. *Polydora ciliata,* A. Agassiz. Ann. Nat. Hist., 3rd ser., vol. xix, p. 247.
„ *Leucodore ciliata,* Malmgren. Annul Polych., p. 95.
1868. *Polydora Agassizii,* Claparède. Annél. Nap., p. 314, pl. xxii, fig. 1.
„ ? „ *calcarea,* Lankester. Ann. Nat. Hist., 4th ser., vol. i, p. 238, pl.. xi.
„ *Leucodore ciliata,* McIntosh. Ibid., pp. 276—295, pls. xviii—xx.
1869. *Polydora ciliata,* Grube. Mitt. St. Vaast, Abh. Schles. Ges., 1869, p. 37.
1873. „ *ciliatum* (=*P. littorea,* n. sp.) Verrill. U. S. Comm. Fish and Fisheries (1871—2), p. 603, pl. xv, fig. 78.
„ „ *ciliata,* Möbius. Pommerania, p. 108.
„ *Leucodore cæca,* Willemoës-Suhm. Zeitschr. f. wiss. Zool., Bd. xxiii, p. 348, Taf. xviii, figs. 4—5.
1874. *Polydora ciliata,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
„ *Leipoceros uviferum,* Möbius. Ibid., vol. xiii, p. 200, pl. xi, figs. 4—14.
„ *Polydora ciliata,* McIntosh. Ency. Brit., ed. 9, vol. ii, Annelida, p. 71, fig. 21.
1875. „ *Agassizii,* Marion and Bobretzky. Ann. Sc. nat., sér. 6, t. xx, p. 83.
„ „ *ciliata,* McIntosh. Invert. and Fishes St. Andrews, p. 127.
„ „ *Agassizii,* Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1879. „ *ciliata,* Tauber. Annul. Danica, p. 118.
1880. „ „ var. *minuta,* Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 91.
1882. „ *ciliatum,* Verrill. Trans. Conn. Acad., vol. iv, p. 301.
1883. „ *ciliata,* Jacobi. Polydoren der Kieler Bucht, Inaug. Dissert., p. 31, etc., Taf. i, figs. 3, 5, 8, 10, 18, 22, 24, etc.
„ „ „ Levinsen. Vidensk. Meddel. For. Kjöbenh., p. 99.
1884–5. *Polydora Agassizii,* Carus. Fauna Medit., i, p. 256.
1887. *Polydora ciliata,* Webster and Benedict. Rep. U. S. Comm. Fish and Fisheries for 1885, p. 737.
„ „ „ Eisig. Monogr. Capitell., p. 335.

1887. *Polydora Agassizi*, Eisig. Monogr. Capitell., p. 335.
1888. *Leucodore ciliata*, Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 641, pl. xxxvii, fig. 5.
1889. „ *audax*, Malaquin. Revue Biol. Nord France, ii, p. 184.
1890. *Polydora ciliata*, Whitelegge. Report Worm-Disease N. S. Wales, Records Austral. Museum, vol. i, no. 2, p. 41, pls. iii and iv.
„ „ „ Malaquin. Annél Boulonn., p. 46.
1891. *Leucodore ciliatus*, Vaillant. Ann. Sc. nat., 7e sér., t. xii, p. 42.
„ *Polydora ciliata*, Joyeux-Laffuie. Bull. Soc. Linn. Normand., 4e sér., t. v, p. 173.
„ „ „ Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 255.
1893. „ „ Lo Bianco. Atti R. Acad. Napoli, ser. 2, v, no. 11, p. 28.
„ „ „ Carazzi. Mitth. Zool. Stat. Neapel, ii, p. 17, tab, ii, figs. 4—5.
„ „ „ Mesnil. Compt. Rend. Acad. Sc., Paris, t. cxviii, p. 643.
„ „ *Giardi*, idem. Ibid., p. 643.
1894. „ *ciliata*, De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 62, pl. iii, figs. 71—73.
1896. „ „ Mesnil. Bull. sc. Fr. Belg., t. xxix, p. 210, pl. xiv, figs. 1—8.
„ „ „ Benham. Camb. Nat. Hist., vol. ii, p. 323.
1899. „ „ Giard. Bull. sc. Fr. Belg., t. xxii, p. 277.
1904. „ „ Allen. Journ. M. B. A., N.S., vol. vii, p. 227.
1908. „ *cornuta*, Salensky. Bull. Acad. Impér. St. Pétersb., p. 688, text-figs. 1 and 2, etc.
1909. „ *ciliata*, Fauvel. Bull. Inst. Ocean., 142, p. 4.
„ „ „ Lo Bianco. Mitt. Zool. St. Neap., Bd. xix, p. 584.
„ „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 169.
„ „ „ Bather. Geol. Mag., Dec. V, vol. vi, p. 108.
1910. „ „ Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 236.
„ „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1913. „ „ Giard. Œuvres Diverses, p. 56.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 103.
„ „ *Giardi*, idem. Ibid., p. 104.

Habitat.—Abundant in both soft and hard varieties of blue shale at the Castle, East and West Rocks, and in sandstone from the same localities, St. Andrews, where it also occurs in various shells, bivalve and univalve. In their galleries in the shale at St. Andrews they are accompanied by the boring *Sipunculas*, young examples of *Dodecaceria* and *Pholoë*, and by *Amphicora* (*Oithonia*) *Fabricii*. Howth, Blacksod and Clew Bays (Southern). Torquay (Elwes).

Abroad it is cosmopolitan. Spitzbergen (Malmgren, Fauvel). Denmark, Sweden, Norway, Iceland, the North Sea, coast of France under *Lithothamnion*, in shells of *Purpura* and in calcareous rocks (De Quatrefages, Keferstein, Giard, De St. Joseph, Mesnil, etc.). Mediterranean, Naples (Claparède). Marseilles (Marion and Bobretzky). Atlantic coast, U.S.A. (Verrill). Australia (Haswell and Whitelegge). Philippine Islands (Benham, Ehlers). Sebastopol (Salensky).

Head (Plate LXXXIX, fig. 4) with the median region (prostomium) elevated and terminating anteriorly in two rounded lobes, with a deep median notch. The ridge runs backward and terminates in an elevation about the anterior border of the third bristled segment. At the sides of the ridge is a considerable amount of dark pigment, which occasionally remains in spirit-preparations, whilst on it are four small black eyes, though this number is not constant. The lateral regions are formed of the peristomium as usual

in the group, and in most preparations each forms a convex anterior margin on each side of the prostomium, whilst in a dorso-ventral view a constriction posteriorly indicates the limit of the segment. The mouth opens on the ventral surface immediately behind the notched rostrum.

The movements of the tentacles (Plate XCIX, figs. 1 and 1 *a*) of this species are most interesting. Thus, in an example, the tubes of which projected from a sandstone covered with Lepraliæ, *Spirorbis*, and small zoophytes—especially *Clava multicornis*—the lashing hither and thither of these delicate filaments was in contrast with the quiet exposure of the plumes of *Spirorbis*, or the rapid fan-like action of the minute *Balani*. Not only are these organs thrown whip-like in various directions, but each undergoes a series of vermiform movements in addition, and as no part of the body or head of the annelid is visible, they resemble a struggling *Ascaris* held by the middle and endeavouring to escape. After lashing the water one or both may bend toward the rock-surface, proceeding rapidly with a serpentine movement, searching in a curious manner any irregularity of the surface. The object of this is apparent when the tentacle meets with a loose particle of sand or mud. The tentacle does not contract, but with a vermiform motion it remains more or less extended, whilst the particle passes along the surface of the organ to the mouth of the tube. If suitable it enters the mouth of the tube, and by-and-by is pushed out along with the head of the annelid to be arranged in the circumference of the tube. The proximity of other tubes causes the tentacles of neighbouring Polydoræ frequently to come into collision, especially when each seizes the same particle of sand or mud, and the stronger bears off the particle. These tentacles (that is their papillæ) thus exercise a sucker-action as well as being endowed with cilia, since they adhere to the plumes of *Spirorbis* and retain a sand-particle in struggling with rival tentacles. Their restless movements, indeed, cause trouble to neighbouring forms such as *Spirorbis*, *Balani*, and the zoophytes. *Polydora* seldom protrudes its head, and on the slightest and most ordinary occurrence, such as a tentacle coming in contact with a branchia of *Spirorbis*, it is rapidly withdrawn. These external tubes appear to be useful in enabling the annelid to take more advantage of the surrounding water whilst its delicate body is protected.

When the fresh tentacle is examined, as, for instance, by seizing it in full extension at the tube (Plate XCIX, fig. 1 *a*), the contracted organ presents a large brownish-green blood-vessel in its centre, and a ciliated groove on its inner surface from base to apex. The tip is provided with distinct papillæ, and these organs also occur throughout the entire length of the groove. Such a structure explains the seizure and retention of a particle as well as its transit from the tip to the base, and, further, leaves the tentacle at liberty to proceed with its captures without having to bend toward the mouth. The muscular power of the tentacles is great, without reference to their almost ceaseless waving. Occasionally a small mass of mud and sand travels outward along the tentacle, and is dropped from its extremity. When removed from its tube the tentacles are much contracted and often coiled like rams' horns, the whole organ being transversely frilled and wrinkled, but the inner groove remains distinct, and for fully three-fourths of its length it is richly ciliated.

The *body* is largest in the anterior third, flattened dorsally and rounded ventrally,

tapered a little anteriorly and more gradually posteriorly, where it ends in a cup-like process with a dorsal notch. The segments vary from sixty to seventy-one or more. Colour in life yellowish-brown or straw-yellow, with the broad, red median dorsal vessel as a conspicuous band. Some have the tentacles marked with dark pigment-bars, and dark pigment often occurs on the snout. Numerous thecate Infusoria occur along the body at the bases of the bristles.

The first foot has a flattened, though rather long and narrow, bluntly-conical dorsal lamella apparently without bristles. The ventral division has a setigerous process and a group of bristles with tapered tips and traces of wings, their direction being slightly backward.

The next three segments have increasingly distinct dorsal and ventral divisions. The dorsal has a well-marked lamella of an elongate conical form, with a tuft of long bristles in front of it arranged in the typical manner, the longest being superior, and all are curved backward. The shorter lower forms have the wings most distinct. All likewise have a backward curve. The ventral division has a short conical lamella or process, in front of which the shorter bristles project. These have very distinct wings, thus increasing the breadth of the tip in certain views.

The fifth bristled segment is indicated by an apparent constriction of the body-wall, a feature due to the absence of lamellæ and the long simple bristles. It bears the large and characteristic strong hook-like bristles or crotchets (the abnormal bristles of Mesnil), besides the dorsal and ventral series of simple tapering winged bristles. The fully developed hooked bristle has a broad base, increases in diameter as far as the middle, and then diminishes to the bend of the hook at the tip (Plate CVI, figs. 2 *b* and 2 *c*). At the bend is a lateral spur, which sometimes escapes observation, and the organ tapers to a point which is more or less acute according to its condition as regards wear. The posterior and developing forms have a much more acute tip. About five have their points projecting beyond the surface, the concavity of the distal curve being directed posteriorly.

The sixth segment has the conical dorsal lamella, longer dorsal bristles, and ventral series of bristles similar to those in front of the fifth, though in an example at St. Andrews an imperfect set of hooks, that is, with the tips indistinct, occur ventrally, whilst the seventh has in addition the first branchia at the inner edge of the dorsal lamella (Plate LXXXVIII, fig. 4), and the ventral division bears winged hooks (Plate CVII, fig. 2 *d*), and these are continued to the posterior end.

The branchiæ begin on the seventh bristled segment as fairly large strap-shaped organs, increase in size to the nineteenth, and then diminish to the twenty-second, which is attached to the twenty-eighth foot in the example under examination, but in others they reach thirty-one in number. Mesnil remarks that only the last ten segments are devoid of vestiges of these organs. This quite differs from the condition in the British examples. The branchia is a strap-shaped structure with a vascular loop in its centre, and a dense line of long cilia along the inner and anterior surfaces. They slightly taper toward the tip, which is bluntly rounded. Bands of cilia occur on the dorsum between the feet.

Immediately behind the branchial region the segments become somewhat wider, then again become narrower, with prominent setigerous processes. The dorsal bristles do not show any marked divergence in length throughout their course, though the first

are shorter than the rest, and those in the neighbourhood of the sucker are longer and more slender in proportion to the breadth of the region.

The terminal sucker (Plate XCVIII, fig. 15) forms a beautiful cup-shaped organ with a dorsal median notch, and a crenation on each side, the rim then curving gently outward to join the general level of the cup. During the various movements of the animal, the notch and the crenations at its side change their appearances, as shown in the several figures.

The winged hooks (Plate CVI, fig. 2 *d*) dilate a little from the base upward to the bold forward curve, then diminish slightly to the neck from which the main fang comes off at more than a right angle. The single spur on the crown is very slightly oblique, that is, nearly approaches the vertical. The wing passes a considerable distance down the neck, touches the tip of the spur on the crown, and forms a border posteriorly. It is perhaps a little shorter in the posterior hooks.

This species also bores in masses of water-logged softened wood, its tubes, about half an inch in length, covering the surface.

Post-larval stages, from tow-nets, are shown in Plate XCIII, figs. 6 and 7.

Larval Polydoræ make their appearance in the bottom tow-net at the beginning of July, and at the surface about the end of that month.

Reproduction.—Numerous ova occurred in the vessels in which ruptured examples were on January 23rd. They are opaque, granular, and somewhat ovoid, and do not show a reticulated capsule, but they are probably immature.

At Naples, Lo Bianco (1909) states that sexual maturity occurs from October to May. The pelagic larvæ are found in February.

What the *Polydora cornuta* of Bosc and others may be is open to doubt. It may be *Polydora ciliata*, though Claparède[1] appeared to think it different from any known form.

Frey and Leuckart (1847) describe under the name of larva of *Leucodorum ciliatum* a Spionid larva in the beginning of July with ten pairs of bristle tufts, the first very long. No sign of the hooks of the fifth segment is seen. The head bears six small eye-specks and two large lateral eyes. A caudal ring of cilia. A muscular pharynx and alimentary canal are outlined.

Claparède (1863) described the development of a form he considered to be *Polydora ciliata* at St. Vaast-la-Hougue. The youngest stage is a rounded trochophore with numerous yolk-granules internally and a ciliated anterior region. In the next stage a tuft of long, jointed provisional bristles occurs at each side behind the projecting shelf or swimming ring with its cilia, and the ventral "bite" for the mouth. Two eyes anteriorly, and two pigment-cells posteriorly, characterise the larva, which has the aspect of two blunt cones joined by their bases. Then a fold or collar develops in front of the swimming ring, with a central and slightly bifid median projection, and five bristled segments, all with the articulated bristles, appear, the first having the longest bristles, the others regularly diminishing. A telotroch is present, and the naked region in front of it has a ciliated band where it joins the preceding segment. The alimentary canal is formed, and the four posterior bristled segments have each a conspicuous stellate pigment-spot. Amongst changes which ensue between this and a later stage with

[1] 'Recherches Anat.,' p. 47, 1864.

seventeen bristled feet, the increased number of eye-specks in the earlier, and their diminution to four in the last stage, the appearance of tentacles, the presence of four rows of stellate pigment-specks on the dorsum of the segments, the development of branchiæ on the seventh and succeeding segments, the last stage (seventeen feet) having five, the formation of the terminal sucker with its dorsal hiatus, the disappearance of the jointed larval bristles, the growth of the capillary bristles and hooks, and the formation of the bifid prow to the cephalic region, are the most noteworthy features. It has to be stated, however, that Claparède saw no change in the fifth bristled segment in his young form, whereas De St. Joseph describes and figures these as present in an example of the same size (seventeen setigerous segments). There is thus uncertainty as to the identity of Claparède's species, unless he had overlooked the fifth segment.

Cunningham and Ramage (1888) seem to doubt the ability of this well-known boring form to penetrate the shells of oysters. As, however, they mentioned that they found it in chinks and clefts of rocks it is possible *P. flava* is referred to. They describe the nephridium as arising from an internal aperture beneath a glandular sac, as mentioned by Claparède, that it is thereafter reflected on itself, and then "passes to open to the exterior near the dorsal median line." The nephridium in their form contained black granular matter.

De St. Joseph[1] (1894) describes and figures a young stage of seventeen setigerous segments with touches of violet on each, six eyes, and developing tentacles. The large hooks occur on the fifth segment, and glands are present from the sixth to the twelfth segment, whilst the anal cup resembles that of the adult.

It is doubtful if the *Polydora cæca* of De St. Joseph[2] (1894) refers to *P. ciliata*, though the figure of the head as given by him may be indifferent. This author figures and describes a young example of *P. ciliata* of about twenty segments.

In going over the single example of the so-called *Polydora Giardi* of Mesnil—kindly forwarded by Major Elwes—the following points have been noted: The specimen is a small one, viz. about a quarter of an inch in length, and Mesnil observes that it is always slender and small as compared with others. The head is devoid of pigment, though, if a young form, such might be expected. No eyes are visible—whether these are absent in the young *P. ciliata* is not noted, but they are irregular even in adults. A distinction is the occurrence of branchiæ on the tenth segment instead of the seventh as in *P. ciliata*. These branchiæ in *P. ciliata* reach thirty-one in number. Now, Mesnil observes that in *P. ciliata* they extend far backward, and that only the last ten segments are devoid of them, whereas in *P. Giardi* they disappear about the twenty-fifth setigerous segment, so that the branchiæ of his *ciliata* differ from the British, whilst those of his *Giardi* agree. Mesnil says there are two to four very small dorsal bristles in the first foot. This is not an important feature. In the example three were on one side and six on the other. The same may be said of the group of the dorsal bristles behind the fifth. The hooks commence on the seventh segment as in *P. ciliata*. Mesnil thinks they differ from those of *P. ciliata* and other forms, but so far as the small example goes they do not appear to differ from those of *P. ciliata* except in size. Mesnil admits that the great hooks of the

[1] 'Ann. Sc. nat.,' 7e sér., t. xvii, p. 63, pl. iii, fig. 73.

[2] Ibid., 7e sér., t. xvii, pl. iii, figs. 65—70.

fifth bristled segment resemble those of *P. ciliata*, and he gives their number as four with a rudiment of a fifth. In *P. ciliata* adults have a larger number, and this opens the question as to whether this *P. Giardi* is not a young form. One difference, however, is apparent, viz. the great prominence of the spur of these hook-like bristles in the so-called *P. Giardi*, which is flattened and mounted. It may be that they have been specially compressed so as to bring the spur into prominence. The caudal funnel is, according to Mesnil, cylindrical with a large hiatus dorsally, but he adds that there are also a ventral hiatus and two lateral, so that there are four divisions with bacilliparous corpuscles as in *Pygospio elegans*. His figure of this (Plate XIII, fig. 9), however, would do for an imperfect representation of the funnel of *P. ciliata*, and the reproduced tail of the sole example from Torquay gives no help.

At present, therefore, *P. Giardi* may only be considered as a young stage of a variety of *P. ciliata*, and it has the same haunts.

With regard to the *Polydora ciliata*, var *minuta* of Langerhans[1] (1880), nothing more can be made out than that it appears to be a small variety of *P. ciliata*.

2. Polydora flava, *Claparède*, 1870. Plate XCIII, fig. 3; Plate XCVIII, figs. 16—16 *d* —feet and tail; Plate C, fig. 10—fifth foot; Plate CVI, figs. 3—3 *c*—bristles and hooks.

Specific Characters.—Bifid prostomium usually longer than in *P. ciliata*, and the divergent processes more distinct. A little pigment on each side of the prostomium in front. No distinct eyes. Median ridge reaches the fourth bristled segment. Body generally larger (2 in. or more in length) than in *P. ciliata* but of similar conformation. Segments over 200. Terminal caudal process with an even rim, so as to form a nearly cylindrical cup.[2] Straw-yellow colour with a brownish central streak, and with red dorsal vessel. First foot has a few dorsal bristles. Fifth segment has large hook-like bristles with tips more distinctly curved than in *P. ciliata* and devoid of spurs. The tip is differentiated in both lateral and antero-posterior views. Dorsal bristles of the anterior twenty segments similar; in the others dissimilar (Carus). Branchiæ commence on the eighth segment, and are from thirty-five to forty in number. The winged hooks begin on the seventh segment.

Synonyms.

1863. *Polydora flava*, Claparède. Mém. Soc. Phys. et Hist. Nat. Genève, t. xx, p. 487.
1870. „ „ idem. Suppl. Annél. Neap., p. 123.
1875. „ „ Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1885. „ „ Carus. Fauna Medit., p. 257.
1887. „ „ Eisig. Monogr. Capitell., p. 335.
1893. „ „ Lo Bianco. Atti R. Accad. Sc. Nap., 2 ser., vol. v, No. 11, p. 31.
„ „ „ Carazzi. Mitth. Zool. Stat. Neapel, Bd. xi, p. 22, Taf. ii, figs. 9 and 18.

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xxxiv, p. 91.

[2] Mesnil states that it has a dorsal notch, and this was also seen at St. Andrews; but he adds that it is sometimes absent.

1893. *Polydora cæca* (pro parte), Mesnil. Compt. Rend. Acad. Sc., t. cxvii, p. 643, 1893.
1894. „ *pusilla*, De St. Joseph. Ann. Sc. nat. 7e sér., xvii, p. 65, pl. iii, figs. 74—77.
1896. „ *flava*, Mesnil. Bull. sc. Fr. Belg., t. xxix, p. 182, pl. xi, figs. 18—26, and pl. xii, figs. 1—22.
1904. „ „ Allen. Journ. M. B. A., n.s., vol. vii, p. 227.
1909. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 169.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
„ „ „ Southern. Proc. Royal Irish Acad., vol. xxviii, p. 236.
1914. „ „ Idem. Ibid., vol. xxxi, No. 47, p. 104.

Habitat.—In chinks of the East Rocks, St. Andrews, along with *Pygospio*. Abundant in its tunnels in *Lithothamnion*, which coats the hard surface of the gneiss between tide-marks in the Channel Islands in company with *Dodecoceria concharum* and *Potamilla reniformis*. Where no perforations could be made, as at Cobo Bay, Guernsey, it is found in the muddy seams of the hard granite. Large examples in *Lithothamnion* dredged in Bressay Sound. Between tide-marks, Lochmaddy, North Uist, also boring in *Lithothamnion*. The examples were not large. In the Atlantic off Paible, North Uist. Howth, Blacksod and Clew Bays (Southern). Plymouth (Allen). Torquay (Elwes).

Elsewhere it frequents the shores of France, both Channel and Mediterranean (De St. Joseph, Mesnil). Naples (Claparède).

Head (Plate XCIII, fig. 3) somewhat resembling that of *P. ciliata*, but the bifid prostomium is longer and more tapered, and its processes are more distinct, whilst the peristomial support at each side is more evenly rounded, anteriorly and laterally. The divergent processes of the prostomium at once attract attention. A little pigment in some occurs on each side of the median ridge (the prostomium) in front, but distinct eyes have not been seen in life or in the preparations. The median ridge passes backward to the fourth bristled segment. The tentacles extend to the fifteenth segment or beyond.

Body of considerable proportional size, a little tapered anteriorly and more distinctly posteriorly, where it terminates in a funnel with a more or less even rim, less expanded at the edge than in *Polydora ciliata*. Attached by the narrow end to the funnel of one example is a pear-shaped crustacean parasite. An unusually long funnel occurred in an example procured at St. Peter Port, Guernsey, in July, but as only a few adjoining segments were attached to it some doubts may exist as to the interpretation of the species. One example, kindly sent by Dr. Allen from Plymouth, had the dorsal margin slightly crenate. As a rule, the ventral margin is more prominent in lateral view. Mesnil found it $4\frac{1}{2}$ cm. long and with two hundred and fifteen segments, but generally the specimens are shorter. Those from Cobo Bay, Guernsey, were 2 inches in length, and those from Plymouth were even longer. The segments, as usual in the group, are distinctly marked.

The caudal cup (Plate XCVIII, fig. 16 *d*) has a very variable outline in fresh examples. Now the dorsal margin is notched with a distinct lobe on each side, whilst the ventral is entire, and again a notch appears in the ventral likewise, so that four lobes characterise the organ. It is therefore difficult to state that the organ in life has a smooth rim, since, generally speaking, the two dorsal lobes with their white pigment are conspicuous, whilst the ventral margin is even.

Of a straw-yellow colour, rarely cream-white, with a brownish central streak

posteriorly from the intestine, and with a red blood-vessel in front and along the centre of the dorsum, each gill also having a red vessel.

The first foot is peculiar in having bristles in its dorsal division, which presents a rounded lamella with a setigerous process in front (Plate XCVIII, figs. 16 and 16 *a*) bearing a small group of tapering bristles slightly curved backward *in situ*. The ventral division has a similar, but somewhat broader, lamella, in front of which is a conspicuous tuft of longer upper and shorter lower bristles, the latter having distinct traces of wings. The second (Plate XCVIII, fig. 16 *b*), third, and fourth feet have completely formed dorsal and ventral divisions. The upper division consists of the long dorsal series and a shorter anterior series (Mesnil) minutely punctated, and of a posterior series intermediate in character, but also punctated. The ventral division has capillary winged bristles in both rows, but at the seventh segment they are replaced by the winged hooks, besides having in a few segments two capillary bristles inferiorly.

The fifth segment (Plate C, fig. 10) has a minute group of dorsal and ventral bristles as in other forms, and the great hook-like bristles (Plate CVI, fig 3 *b*) have the concavity of their tips directed backward, and are arranged in a curve. In the ordinary condition the shaft enlarges from the base upward to the middle, then slightly diminishes to the tip, which forms a lever-like hook with a convexity posteriorly and an excavation in front. The hook is more marked in some examples than in others. They are accompanied by a series of small spear-shaped bristles. In the developing hook the distal curve is very marked, and a small shoulder appears at the base of the concavity in front, whilst a lateral dimple and elevation, as well as a differentiation at the commencement of the terminal curve posteriorly, are evident. In frontal view, as Mesnil shows, the distal region is likewise differentiated.

As a rule about six hooks are well developed on each side, and they form a gradational series, commencing with one in which the blunt tip is scarcely curved and ending with those in which the curvature at the sharp tip is marked. The developing forms (two or three) have sharp, curved tips, but no trace of a spur is visible. They are accompanied by bristles with peculiar elongate tips, the sides of which are nearly parallel, and the tip in some is blunt.

The winged hooks (Plate CVI, fig. 3 *c*) dilate very little above the base, and have a marked forward curve throughout the greater part of their length, then a backward bend below the neck, diminishing toward the latter. The main fang comes off at a considerable angle to the neck, is sharp, and the spike on the crown has a less angle with the main fang than in *P. ciliata*. The wings are similar.

The dorsal bristles become extremely slender posteriorly, but are of considerable proportional length. Moreover the posterior region has bundles of bristles even more slender than the foregoing in each foot (Mesnil states, dorsal). Each bundle contains many, and they resemble linear crystals, being perfectly straight and slightly tapered at each end. The function of these is unknown. Mesnil observes that they are entirely caducous, and do not appear in front of the eighth bristled segment; and at Guernsey it was thought they were at the hook pads. The bacillary pouches seem only to contain granules, larger than in *Magelona*.

The branchiæ commence on the eighth segment, attain their maximum size a few

segments behind, and then diminish. They appear to be about thirty-five to forty in number. Long cilia occur on them.

In an example from Lochmaddy a large hook-like bristle of the fifth segment had its tip apparently in process of reproduction, and it somewhat resembled in this condition the hook-like bristles of *P. Mesnili*.

In the alimentary canal of those from Guernsey are numerous Gregarinæ of a short, thick outline.

A feature of moment occasionally observed on the surface of the *Lithothamnion* from Guernsey is the fact that from the rounded aperture a curved groove proceeded some distance and then ceased. Its depth would correspond to about half the diameter of the body of the annelid, and, all things being taken into consideration, would be most easily explained by the action of a solvent secreted on the body of the worm when applied to the surface or from constant friction; but, of course, this is conjectural, and the fact that *P. ciliata* bores as readily in aluminous shale shows that other agencies must be considered.

The surface of the *Lithothamnion* is dotted over with minute apertures, some of which are in pairs, but others, generally a little larger, are not. The smooth surface of the alga does not show the tubes of sand and mud so characteristic of the perforations of *P. ciliata* in shale and sandstone.

On April 21st an example discharged a quantity of yellowish ova in its vessel—each being about 0·09 inches in diameter.

Claparède (1870) considered that the large bristles of the fifth segment represented neither the dorsal nor the ventral tufts, since in *P. Agassizii* there exists a distinct ventral tuft, whereas in *P. antennata* the reverse occurs, viz. the presence of a dorsal tuft. He was apparently unaware of the presence of both dorsal and ventral tufts in *P. ciliata*.

Mesnil considers that the morphology of the bristles in the fifth segment of this and other species is as follows:—The dorsal tuft comprises superior dorsal bristles, the abnormal (hook-like large bristles) as the posterior dorsal, the capillary which accompany them as the anterior dorsal; whilst the small ventral tuft he regards as the entire normal ventral series. He places considerable weight on the presence of packets of fine bristles included in the foot, and which are absent in *P. cæca* of Œrsted,[1] and he therefore separates the latter species, which Œrsted described as blind. Mesnil[2] found it (*P. cæca*) not in muddy tubes like *P. flava* and *polybranchia*, but in tunnels in the calcareous alga *Lithothamnion*. This form closely resembles *P. flava*, the branchiæ commencing on the same segment (eighth). At the forty-fifth to the fiftieth setigerous segment the anterior dorsal bristles are altered, for the wing is absent, and they are stout, short, and pointed, constituting a distinctive character of the species, which, however, is not given by Œrsted. The great hooks of the fifth segment resemble those of *P. flava*. Mesnil also states that the great fang of the winged hook has an angle of 60° instead of 45°, as in *P. flava*. Moreover, he found a young example with four eyes as in the ordinary form. It has only seventy to eighty segments. If this form is really distinct from *P. flava* it should occur on the southern shores of Britain.

[1] 'Consp. Annul. Danica,' p. 39, fig. 104.

[2] 'Bull. sc. Fr. et Belg.,' t. xxix, p. 19, pl. xii, figs. 23—29.

A specimen, *Polydora cæca*, of Œrsted, mounted on a slide, was kindly sent by Col. Elwes from Babbacombe. Œrsted distinguishes it anteriorly by "rostro capitis in duas appendiculas acuminatas producto, oculis nullis"; fifth segment six to seven "aciculi," whereas *L. ciliatum*, Johnston, has "rostro lobis rotundatis," "oculis quatuor, aciculis 11—12." Nothing can be made out of Œrsted's figures of the hook and bristle (Tab. II, fig. 16). De St. Joseph's important points of the same form are: "Colourless or faintly yellow. Head with remarkably small, median bifid prow, no eyes; four to six acicular bristles with curved obtuse points, having two rudimentary spurs," as Claparède figures in *Polydora cornuta*, Bosc, though he met with an example having the bristles of one side with only one rudimentary spur (*croc*). They are accompanied by peculiar bristles "boulette." So far as can be made out these are certainly less acute than in a fresh *Polydora ciliata*, but the action of the calcareous rocks may have affected them. There is nothing distinctive in Willemoës-Suhm's[1] account, and as his figure has what appears to be branchiæ from the first segment backward (except the fifth), there may have been misapprehension. Carazzi is therefore in all probability right in joining *Polydora cæca* to another form, viz. *P. flava*, and so far as could be seen in the specimen from Babbacombe it could not be separated from *P. flava*.

3. Polydora quadrilobata, *Jacobi*, 1883. Plate XCVIII, fig. 13—caudal region; fig. 17—foot; Plate C, fig. 9—fifth foot; Plate CVI, figs. 4—4*c*—bristles and hooks.

Specific Characters.—Head with smaller prostomial lobes than in *P. flava*, and the ridge goes backward to the fourth bristled segment. The snout differs from most of the other forms in its conical outline, for the peristomial supports taper anteriorly. Body typical so far as the imperfect example shows, though posteriorly the terminal process is four-lobed. Branchiæ commence on the seventh bristled segment. The fifth foot is distinguished by the large size and conspicuous condition of the dorsal capillary bristles, which have the tips bent at an angle to the shaft and tapered to a fine point, with wings. The large hook-like bristles dilate from the base to the last third, then slightly diminish to the throat, from which a short tip comes off at considerably more than a right angle and soon ends in a bifid stumpy point. The winged hooks commence on the seventh bristled segment, and in their structure do not present any diagnostic feature of note.

Synonyms.

1883.	*Polydora quadrilobata,*	Jacobi.	Anat. Histol. Untersuch. Wissenfels, p. 1.
1887.	„	„	Eisig. Monogr. Capitell., p. 335.
1896.	„	„	Mesnil. Bull. sc. Fr. et Belg., t. xxix, p. 236.
1897.	„	„	idem. Ibid., t. xxx, p. 87, pl. iii, figs. 9—11.
„	„	„	Michaelsen. Polych. deutsch. Meere, p. 44
1909.	„	„	McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 170, pl. v, fig. 2.

In *Lithothamnion*, dredged in Bressay Sound, and obtained between tide-marks at Lerwick (W. C. M.), July, 1871.

Abroad it has occurred at Kiel (Jacobi); German waters, Sound, and Belt (Michaelsen).

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xxiii, p. 348, figs. 4—5.

The *head* has smaller prostomial processes than in *P. flava* and the median ridge appears to pass backward to the fourth bristled segment. Neither eyes nor pigment are visible in the preparation, which consists of a fragment of the anterior region. The anterior end differs from that in *P. flava* not only in the small prostomial process, but in the conical outline, for the peristomial supports taper forward so as to make the anterior end conical instead of the boldly convex lateral region on each side as in *P. flava*. The arrangement of the bristles in the first four segments appears to be typical, though they are somewhat shorter than in *P. flava* and *P. ciliata*, and the groups in the dorsal division are clearly differentiated.

The fifth foot (Plate C, fig. 9) is distinguished by the large size and conspicuous condition of the dorsal capillary bristles, which are six in number, for the expanded tip is bent at an angle to the shaft and the tapered end is again curved, thus giving the aspect of a pointed bill-hook. The great hook-like bristles dilate from the base upward for fully two-thirds of their length, then slightly diminish to the throat, from which a short tip comes off at considerably more than a right angle, and soon ends in a bifid stumpy tip (Plate CVI, fig. 4 *b*), characteristically different from that of any other species. In some views a cavity appears in the centre of the tip, with the short points guarding its boundary. Six or seven occur on each side, but the tips of only four or five project from the surface. The bifid tip is well shown in the developing forms. The ventral capillary tuft is considerably smaller than the dorsal, but the type of tapered bristles with a short tip is maintained on a diminished scale.

So far as could be observed the branchiæ appeared on the seventh or eighth bristled segment, and so with the hooks (Plate CVI, fig. 4 *c*), which do not differ materially from those of *P. ciliata*; the curve of the shaft is similar, but the main fang seems to form a larger angle with the neck and the spike on the crown is less erect, but these differences may be partly due to position. The dorsal lamella of the foot appear to be small. The body terminates posteriorly in a four-lobed process, the two dorsal being the larger (Plate XCVIII, fig. 13).

This species is due to the acuteness of Jacobi, who wrote his inaugural dissertation on the Polydoræ of Kiel Bay.

Mesnil (1897) observed four eyes and an intermediate pair. The tips of the great hook-like bristles of the fifth segment, he states, resemble those in *P. polybranchia*.

4. Polydora Caulleryi,[1] *Mesnil*, 1897. Plate C, fig. 8—fifth foot; Plate CVI, figs. 5—5 *d*—bristles and hooks.

Specific Characters.—Prostomium forms a smoothly-rounded anterior termination projecting a little in front of the rounded lobes of the peristomium. Median ridge slightly contracted behind the anterior end, and passes backward to the fourth bristled segment. Body tapers in front only from the fourth bristled segment to the snout, the rest to the twenty-fifth segment having nearly parallel sides. The fifth bristled segment is fully in a line with the others. Branchiæ appear on the seventh or eighth bristled segment. The first foot has both a dorsal and a ventral lamella, but only ventral bristles.

[1] Named after the distinguished Professor of the Sorbonne, Paris.

The fifth foot is prominent, and dorsally bears a tuft of strong capillary bristles with flattened, winged, and rather short tapering tips bent abruptly backward. The great hook-like bristles have the points of the main fang directed backward and slightly upward; shaft broad, flattened, dilating from the base to the distal third, where a slight backward curve and diminution occurs to the throat; but, whilst the inner curve is even, the outer has a slight projection or shoulder rather below the level of the throat. The strong main fang comes off at a little more than a right angle, and the point is by no means acute. The crown of the fang has the upper surface flattened and prominent on each side, whilst superiorly a comb-like crest with a serrated edge curves from the back of the crown almost to the point of the fang. Winged hooks of the ordinary form with a sharp main fang and a spur on the crown above commence in the ventral division of the seventh segment.

Synonyms.

1897. *Polydora Caulleryi*, Mesnil. Bull. sc. Fr. et Belg., t. xxx, p. 88, pl. iii, figs. 12—16.
1909. „ *Carazzi*, McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 172, pl. v, figs. 4—6.

Habitat.—A large example occurred in the shale at the Castle Rocks, St. Andrews, February, 1865. A single specimen obtained between tide-marks at Lochmaddy, North Uist, August, 1865.

Elsewhere it has been procured on the shores of France (Cap de la Hague), Mesnil, who found his specimen on a *Platycarcinus pagurus* covered with *Pomatoceros triquater*.

The *head* characteristically differs from that of any other species of the genus, in that the anterior end of the prostomium forms a smoothly-rounded prow projecting very little in front of the rounded lobes of the peristomium at the sides. The median ridge is slightly contracted behind the rounded anterior promontory, and, passing backward, terminates at the fourth bristled segment. The mouth opens beneath as a long (acute) triangle, with the prominent lip on each side. No eyes are visible and no pigment.

The *body*, of which there is only the anterior region of twenty-five or twenty-six bristled segments, tapers from the fourth bristled segment to the snout, the rest having nearly the same diameter, and it is a feature that the fifth bristled segment is fully in a line with the others, its antero-posterior diameter being as usual greater than in the segments adjoining.

The first foot has both a dorsal and a ventral lamella, but only a tuft of ventral bristles, the tips being directed rather outward than backward, the convexity of the curve, however, being forward. They are shorter than those immediately following. The second, third, and fourth feet have lamellæ and dorsal and ventral bristles agreeing with those of other forms.

The fifth foot (Plate C, fig. 8) is remarkably prominent, and dorsally bears a strong tuft of capillary bristles, the flattened, winged, and rather short tips of which curve somewhat abruptly backward. The great hook-like bristles have the points of the main fang directed backward and slightly upward. Each consists of a broad flattened shaft (Plate CVI, figs. 5 *b* and 5 *c*), which dilates from the base to the distal third, where a slight backward curve and diminution ensue at the throat, but, whilst the inner outline is even, the outer shows a slight projection situated rather below the throat, which is by no

means narrow. The strong main fang comes off at a little more than a right angle, and the tip is somewhat blunt. Moreover, the crown of the fang seems to have the upper edge flattened and prominent on each side, whilst above it a comb-like crest with a serrated edge curves from the back of the crown almost to the point of the fang, so that *uncinus crista-galli* might be an appropriate name for such a hooked bristle. Indications of striæ, which slope from behind forward and upward, show that this crest is an aggregate of spines. The ventral tuft in this segment is small, only a few bristles being present.

The sixth bristled segment has lamellæ and dorsal and ventral bristles (Plate CVI, figs. 5 and 5 *a*) like the fourth. Winged hooks occur in the ventral of the seventh, and the branchiæ would appear to commence in this segment, though the state of the specimen left uncertainty as to the particular foot.

The hooks (Plate CVI, fig. 5 *d*) do not offer any diagnostic feature, save their small size, having the same curves and arrangement of the main fang and its spur on the crown as in *P. flava* and others. The wings arise about the site of the backward curve of the shaft, and the anterior edge passes straight upward to the point of the main fang.

In contrast with *P. flava* the lamellæ of the feet generally and the bristles are shorter in *P. Caulleryi*, whilst the hooks project similarly in both.

The species seems to be sparingly distributed, and at first Mesnil's account was overlooked, the title of *P. Carazzi*, which now lapses, having been given to it.

In his account of this as a new species, Mesnil (1897) overlooked, probably from the imperfection of his specimens, the distinctive character of the prostomium.

5. Polydora hoplura, *Claparède*, 1868. Plate CI, fig. 10—posterior hook-like bristle; Plate CVI, figs. 6—6 *c*—bristles and hooks.

Specific Characters.—Head similar to that of *P. ciliata*, except in the absence of the black pigment in the preparations. Eyes four. The prostomial prow has a median notch and two rounded lateral processes. Body of the typical form, 35 mm. long. Segments about 130. Branchiæ commence on the seventh foot. Fifth segment bears large hook-like bristles, which are distinguished by the parallel arrangement of the shafts and tips, the latter being peculiarly bent, and by no means sharp; and they have a strong lateral spur on the neck. Winged hooks occur in the ventral division of the seventh foot, whilst in the last fifteen segments curiously curved sharp hook-like bristles take their places. The terminal sucker is somewhat like that of *P. ciliata*, with a dorsal notch. Colour dull red (Lo Bianco).

Synonyms.

1868. *Polydora hoplura*, Claparède. Annél. Nap., p. 318, pl. xxii, fig. 2.
1875. „ „ Marion and Bobretzky. Ann. Sc. nat., 6e sér., t. ii, p. 84.
„ „ „ Panceri. Atti Soc. Ital., vol. xviii, p. 528.
1879. „ *hamata*, Webster. Trans. Albany Inst., vol. ix, p. 51.
1880. „ „ Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 91, Taf. iv, fig. 4.
1883. „ *hoplura*, Carazzi. Mitt. Zool. Stat. Neapel, Bd. xi, p. 20, Taf. ii, figs. 6 and 7.
1893. „ „ Lo Bianco. Atti R. Accad. Sc. Nap., 2 ser., vol. v, No. 11, p. 30.
1894. „ „ De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 65.

1909. *Polydora hoplura*, McIntosh. Ann. Nat. Hist., ser. 8, vol. iii, p. 173.
„ „ „ Lo Bianco. Mitt. Zool. Stat. Neapel, Bd. xix, p. 584.
1910. „ „ Bather. Geol. Mag., Dec. V, vol. vii, p. 114.
1911. „ „ Journ. M. B. A., vol. vii, p. 228.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 103.

Habitat.—Between tide-marks, Lochmaddy, North Uist, and amongst *Polydora ciliata* at the Castle Rocks, St. Andrews. Plymouth (Allen). Clare Island district (Southern).

Abroad it occurs on the Shores of France, perforating oysters (De St. Joseph, Mesnil). Mediterranean (Claparède, who discovered it in the tests of *Balani* at Naples). Marseilles (Marion and Bobretzky).

The *head* of this form does not differ much from that of *P. ciliata*, with which it associates at St. Andrews, except in the absence of the dark pigment on the snout in the preparations, and, perhaps, its slightly smaller proportions. The prostomial prow has a median notch and two rounded lateral regions.

The arrangement and shape of the lamellæ and bristles of the first four bristled segments are also like those of *P. ciliata*.

The fifth segment bears hook-like bristles which are distinguished at first sight from those of *P. ciliata* by their parallel arrangement in the group *in situ*, especially at the tips, a feature due to their more uniform diameter, by their peculiarly curved and by no means sharp tips, and by the position and size of the lateral spur at the neck (Plate CVI, figs. 6 *a* and 6 *b*).

The branchiæ commence on the seventh segment, as also do the winged hooks (Plate CVI, fig. 6 *c*), which show rather a long, sharp main fang, coming off nearly at a right angle with a single spur above.

The feature most diagnostic of this species was unfortunately absent in the imperfect specimen, viz. the presence of the hook-like bristles (Plate CI, fig. 10) in the last fifteen segments. From Claparède's figure these apparently occupied the ventral division to the exclusion of the winged hooks. An example sent by Mr. Southern enabled the figure to be made.

Reproduction.—At Naples the period of sexual maturity, according to Lo Bianco (1909), is from June to November.

Claparède (1868) describes a peculiar series of vascular loops or lozenge-like figures formed in the region occupied by the sexual elements on the ventral surface, and a glomerulus at the base of the branchiæ. The first segmental organs occur in the ninth segment.

Genus CIII.—Prionospio,[1] *Malmgren*, 1867.

Cephalic region short, truncate in front, a little elevated and subrectangular in outline. Tentacles not conspicuous. Eyes present or absent. Body elongate, sublinear, a little attenuated posteriorly. Setigerous tubercles with flattened lamellæ which are large in the first four segments. Branchiæ four pairs in the anterior segments, dorsally adnate, the first and fourth having a long pinnate process, that of the second and third being much shorter and filiform. Bristles in the anterior segments capillary in both divisions, in the

[1] Πζίων et Σπείρη.

posterior segments capillary in the dorsal and capillary and uncinate in the ventral division. Anteriorly the capillary bristles have an attenuate tip with narrow wings, whilst the posterior bristles are devoid of wings. In the middle of the body the inferior ventral bristles are strongly curved at the tip as well as winged. The hooks are winged, with a main fang and a spike above it.

In the anterior third of the body of *Prionospio Steenstrupi* a transverse section presents well-developed cuticle and hypoderm, the latter especially being thick in the lateral processes, and on the ventral surface external to and at the sides of the nerve-cords. The dorsal longitudinal muscles are of average size, and the inner ends are slightly tapered as they approach the middle line above the dorsal blood-vessel. The ventral longitudinal muscles, which occupy a limited elliptical area, are also of average bulk, and in section show vertically curved fasciculi externally and nearly horizontal fasciculi internally. In this region a powerful series of fibres passes from the dorsum about the middle of the longitudinal muscle, which is pierced, to the mid-ventral surface, probably in connection with the proboscis, which forms a comparatively large and thick-walled organ with a foliate arrangement of its mucous lining; an external coat of longitudinal and an internal layer of circular muscular fibres besides its external sheath. The mid-dorsal and mid-ventral vascular trunks are large, the latter lying between the ventral ends of the strong oblique muscles; these are inserted over the neural canals, which are large and situated at the upper border of the nerve area, the rest of the area being hypodermic.

Prionospio Malmgreni, *Claparède*, 1868. Plate XCVIII, fig. 12—snout; Plate CXI, figs. 1—1 *b*—head and body; fig. 1 *c*—anterior foot. Plate CIX, figs. 15 and 15 *a*—bristles; fig. 15 *b*—hook.

Specific Characters.—Cephalic region truncated anteriorly, with four eyes, two anterior rounded, composed of several crystalline spheres and dark pigment, and after an interval, two elongated or reniform masses of pigment. A cephalic ridge occurs in the median line with a pointed process posteriorly. Body elongated like that of a small Nereid, but anteriorly characteristically enlarged, whilst posteriorly it gently tapers to the vent, which has two subulate cirri. Branchiæ two pairs on the third and fourth bristled feet. Second and fifth bristled segments bear moderately long pinnate cirri. The first ten segments have simple bristles dorsally and ventrally, the simple, yet strongly curved bristles, projecting in front of the lamella and presenting a granular condition of the central axis. Hooks commencing on the fourteenth or fifteenth segment, a single tooth above the main fang. Length $\frac{3}{4}$ in. Neapolitan examples 4 cm. long and 2 mm. broad, eighty-five to ninety segments. Colour yellowish-brown anteriorly, whitish posteriorly (male). Tubicolar; in fine mud.

Synonyms.

1868.	*Prionospio Malmgreni,*	Claparède.	Annel. Chétop. Naples, p. 333, pl. xxii, fig. 3.
1910.	„ *Steenstrupi,*	Southern.	Proc. Roy. Irish Acad., vol. xxviii, p. 236.
1914.	„ *Malmgreni,*	McIntosh.	Ann. Nat. Hist., ser. 8, vol. xiii, p. 82.
„	„ „	Southern.	Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 102.

Habitat.—Procured in the tow-net attached to the trawl off Balbriggan, Ireland; Ardfry, Galway Bay; Irish Sea; Blacksod Bay and Clew Bay (Southern).

The minuteness of the preserved specimens made it difficult to determine the presence or absence of a cephalic ridge, but so far as could be seen it was present. The head terminates anteriorly in a truncated snout, with four eyes, two rounded, anterior composed of several crystalline spheres and dark pigment, and after an interval two elongated or kidney-shaped masses of pigment. This form is thus in contrast with the Canadian, in almost every example of which, as mentioned, the extended proboscis had distorted the snout. The proboscis in the latter had a slightly tapered basal process with a button-like tip. A much more prominent cephalic ridge occupied the centre of the dorsum, and terminated posteriorly in a pointed process like an adnate tentacle. It closely agrees, however, with *P. Malmgreni* of Claparède.

The body is elongated, resembling posteriorly that of a small Nereid, but anteriorly characteristically enlarged, and gently tapering posteriorly to the vent, which has two cirri. Claparède's examples were all small, viz., 11—12 mm., yet the females were mature, a bunch of orange ova occurring on each side of the intestine behind the fifteenth segment.

In his original description Malmgren states that there are four pairs of branchiæ, the basal region of the long tapering forms as pinnate, the distal as filiform (referring to the elongate pinnate cirri of the front and rear of the anterior region). He, however, observes that these are longer than the branchiæ of his second and third segments (for he apparently overlooked the minute anterior feet); yet he does not differentiate these from the dorsal lamella of the feet, which are truly "ovate-lanceolate," whilst the true branchiæ, which he apparently represents in his Fig. 55A, Taf. X, are broadly strap-shaped, only a little tapered at the tip, which ends in a conical process or mucro. Moreover, they are closely striated transversely and richly ciliated, whereas the pinnate processes and the lamella of the feet are not. Claparède, again, expressed doubt as to the actual number of branchiæ from the facility with which these delicate organs break off. He, however, considered the pinnate cirri as branchiæ, though he found no cilia on them. In his figure (Plate 22, fig. 3) none of the ligulate (true) branchiæ are shown, and the position of the posterior pair of the pinnate cirri is faulty.

In the first foot the dorsal and ventral lamellæ are rounded and rudimentary, and the tufts of bristles small; moreover, the granular condition of the axis of the bristle was not made out. The second foot has the dorsal lamella of a lanceolate outline, whilst the ventral is rounded. Both dorsal and ventral bristles showed a granular condition of the axis, so that it (axis) appeared to have minute transverse bars in the centre (Plate I, fig. 6).

In the third, fourth, and fifth feet the dorsal lamella largely increases in size as a broadly lanceolate process, but in the third and fourth it is considerably less than the elongate branchia which forms a conspicuous process on the inner side of each, and readily distinguished by the transverse lines. These branchiæ are much longer than those in the Canadian form, and the tip differs in its tapered condition. They are also proportionally larger and longer than in the *P. plumosa* of Sars. The first ten segments are conspicuously bristled, the strongly curved dorsal and ventral bristles projecting laterally in front of the lamellæ. The eleventh has more slender capillary bristles. Claparède stated

that the hooks commenced on the fifteenth segment, but Mr. Southern described them on the twelfth bristled segment. When this feature was examined the specimens were much injured, so that exactitude was not possible. They seemed to begin about the fourteenth or fifteenth.

The three forms mentioned above, viz. Malmgren's, Sars', and Claparède's, have each distinctive features, yet some of these may be due to imperfections in observation and to variation. Certainly the bristles and hooks are very similar. The occurrence of mature females in Claparède's small form, also recently procured by Mr. Southern, would seem to militate against its being a young annelid. Moreover, the silence in connection with the cephalic ridge and the absence of eyes in it and also in Malmgren's species is another source of dubiety. The Canadian, the Arctic examples procured by the "Valorous," and the *P. plumosa* of Sars, all present such a ridge, and it is possible Malmgren may have overlooked it, since in some it is inconspicuous, especially in the small Irish forms, yet it is observable, as Mr. Southern[1] also testifies. Future investigation may clear up the ambiguities connected with the several forms, and may even link them together as variations of one species.

Prionospio Steenstrupi, *Malmgren*, 1867.

Specific Characters.—Cephalic region with a median ridge and no eyes. Body elongated, slightly flattened, and having 100 or more segments. Pinnate cirri much longer than the branchiæ of the fourth and fifth segments, which have ovate-lanceolate lamellæ on the dorsum. The inferior lamella in the anterior segments is sub-rotundate.

Body terminates posteriorly in an anus with two cirri. Ten anterior segments have capillary bristles in both divisions. Bristles of the posterior feet are considerably longer and more slender. Hooks commence about the fifteenth segment.

Colour in spirit pale.

Synonyms.

1867.	*Prionospio Steenstrupi*,	Malmgren.	Annul. Polych., p. 202, Tab. x, fig. 55.
1880.	„	„	Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 90, Taf. iv, fig. 3.
1882.	„	„	Levinsen. Vid. Medd. Nat. Foren., p. 98.
1893.	„	„	idem. Kan. 'Hauchs,' Hft. v, p. 335.
1894.	„	„	Bidenkap. Norges Annul., p. 93.
„	„	„	McIntosh. Ann. Nat. Hist., ser. 8, vol. xiii, p. 82, pl. 6, figs. 1—8.
„	„	„	Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 101.

Prionospio Steenstrupi occurs off Iceland on a muddy bottom in 40 fathoms (Lovell).

A Canadian form, apparently the *Prionospio Steenstrupi*, Malmgren, dredged by Dr. Whiteaves in the Gulf of St. Lawrence, Canada, presents certain differences from Malmgren's description, and approaches that described by Sars. It forms a useful comparison with the Irish representative. No complete example is in the collection and no satisfactory fragment of the posterior end—all presenting signs of mutilation and regeneration. The proboscis was extruded in every case, so that the snout was more or less distorted, the protruded organ forming a button-like process on the end of a short

[1] Mr. Southern kindly sent two specimens and thus enabled the figures to be made.

cone. The snout had the ordinary truncate anterior border without a trace of eyes, but on the dorsum a cephalic ridge extended along the median line and terminated posteriorly in a pointed process like an adnate tentacle about the line of the third foot. The body presented the normal outline, and when complete probably had about 100 segments, the number given by Malmgren for the northern example.

The first foot is minute and consists of a fan-shaped dorsal lamella and a smaller ventral one of ovoid outline, one side forming the adherent base. In front of the dorsal is a group of strong tapering bristles with a basal curvature and a very finely tapered tip, the centre of each being minutely granular, whilst the slender tip is homogeneous. The ventral tuft is composed of bristles almost straight, but having as finely tapered tips. No wings could be defined in the bristles of this foot, and the tufts were nearly equal in size.

In the second foot the dorsal lamella has become broadly lanceolate, its lower border being bluntly rounded, the upper somewhat pointed. The ventral lobe is elongate-ovoid with the free end pointing downward. The curvature of the dorsal bristles is less marked, the centre of the shaft is less distinctly granular, and there is a barely visible trace of a wing. The ventral bristles, on the other hand, are more evidently curved, are larger and of two kinds, longer curved finely tapered forms with minute granules in the shaft and a finely tapered tip without wings, and shorter bristles with translucent shafts, narrow wings, and finely-tapered tips.

The third foot of the Canadian form has a considerably larger dorsal lamella, and has the pinnate process in front, but it carries no branchia. The next two feet (fourth and fifth), however, bear well-developed branchiæ, that following (sixth) having a conspicuous dorsal lamella and a pinnate process on each side. In the succeeding feet the dorsal lamella gradually diminishes, so that at the fourth from the posterior pinnate process both lamellæ are much reduced and the capillary bristles thus rendered conspicuous. Posteriorly the lobes of the feet diminish greatly, whilst the dorsal bristles become longer and so slender as to be hair-like. Ventrally hooks take the place of the anterior bristles from the fifteenth foot backward. In this form the pinnate or papillose cirri were sparsely covered by the somewhat clavate, long papillæ, which became shorter and ceased about the commencement of the distal third of the process, and thus contrasted with the condition in the *Prionospio plumosa* of Sars. The dorsal bristles consisted of winged forms and of others in which the wing was not distinct, but which had the axis granular and so arranged in some as to give a transversely barred appearance. In the middle of the body the ventral row of hooks, besides a few very slender capillary forms, had at the ventral edge a single, strong curved bristle. The hooks were rather slender and long, with a main fang and two or three teeth above it in lateral view. The branchia is apparently broader than Malmgren's figure would indicate, and broader than the form described by Sars or in that from the 'Valorous,' but it is less elongate than that of the British form—the *Prionospio Malmgreni* of Claparède.

Genus CIV.—Magelona, *Fritz Müller*, 1858.

Mœa, Johnston.

Prostomium elliptical, greatly extended and muscular; tentacles vascular with large

closely arranged papillæ; proboscis extrusible; complex vascular system with pink corpuscles. Body of three divergent regions, the middle of only a single segment. No branchiæ. Two anal cirri.

In the structure of the snout *Magelona* offers features *sui generis*, but, as they have been already minutely described,[1] only a brief epitome is necessary here. The snout is remarkably flattened, eyeless, translucent, and thinned at the margins like a sharp-edged spatula. It is covered with cuticle and hypoderm, and beneath has a median and a lateral pair of longitudinal muscles, which are supported by a chitinoid basement-tissue in the form of a crown, the whole giving firmness to the snout in its ceaseless thrusts into the sand, aiding its muscles, and confining their actions to the most favourable lines. Moreover the flexible chitinoid plates—even more than the beams of a ship—lend the necessary power of resistance to the yielding tissues of the snout and protect the blood-vessels. The median muscles cease when they reach the line of the tentacles. The lateral muscles take origin a little behind the median, form ribbon-shaped bands, become narrower toward the mouth, and are continued backward to the tail as the ventral longitudinal muscles. A powerful transverse muscle in front of the mouth connects the inferior ends of the external chitinoid septa, and the space is further subdivided by vertical fibres. The powerful band is the chief agent in narrowing the snout.

The dorsal longitudinal muscles take origin between the forks of the chitinoid process over the mouth as narrow bands, wider as far as the sixth setigerous process, then diminish to the ninth, and again spread out thereafter, being at first separated by an intermediate hypodermic process which passes downward to the apex of the oblique muscle and the alimentary and vascular systems beneath. Then a simple sulcus is left, from which the fasciculi in transverse section pass off in a pennate manner, and this continues posteriorly, only disappearing before the termination of the muscle at the tip of the tail. Externally a thin layer of circular fibres envelops the body-wall beneath the hypodermic basement-tissue, and is continuous to the posterior end of the worm.

In the oral region the muscular system is complex, and amongst others the transverse dorsal muscle extends from the anterior border of the mouth to a little behind the tentacular bases. Some of the vertical fibres are attached to the proboscis, others to the chitinoid plates in company with the large transverse ventral muscle. The whole body-cavity, by the aid of these muscles, can be firmly compressed, and the proboscis expelled. Both vertical and oblique muscles attain great development throughout the entire anterior region, so as to act as powerful compressors, whilst their elongation and contraction directly affect the blood-channels. Moreover, immediately in front of the ninth segment the relations of the muscles are unchanged; but it is now observed that a series of muscular fibres arise from the superior insertion of the vertical, outward along the whole upper arch of the body, and indeed to a point considerably below the upper fibres of the oblique. They by-and-by form a powerful fan-shaped mass extending from the raphe of the dorsal longitudinal muscles, and even over them, to the edge of the ventral longitudinal muscles inferiorly, and converging to the raphe at their inner border. Some fibres also pass into the transverse ventral muscle so as to form a continuous

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xxxi, p. 401, pl. xxix—xxxviii, 1877.

band. The direction of the fibres of this great muscular expansion is not straight or vertical, but they curve from before backward as well as from above downward and inward. The foregoing arrangement at the ninth segment thus holds the whole body-cavity in control, and, like the complex muscles of the vertebrate heart, must materially aid the blood-vessels in propelling the blood forward into the anterior region and in keeping it there, during the contraction of the other muscles of the part, by firm closure of the channel of communication. The importance, therefore, of this fan-like muscle on each side in regard to the functions of the proboscis is apparent.

As soon as the body-wall becomes continuous behind the mouth a series of transverse fibres pass from the raphe at the inner end of each longitudinal ventral muscle quite

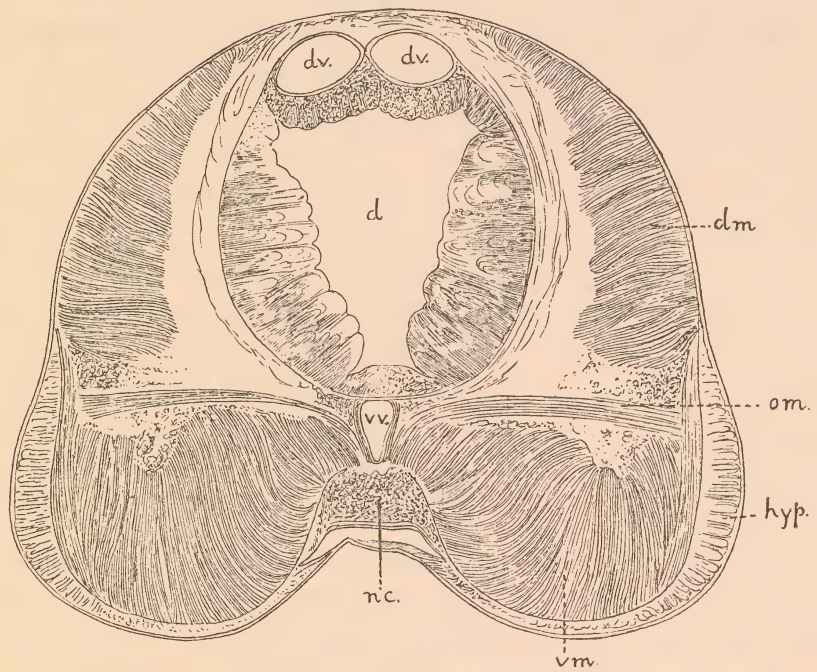

Fig. 124.—Transverse section of *Magelona papillicornis*, F. Müller, in the anterior third.

across the body, and thus form a very efficient expulsive system for the proboscis as well as a barrier after extrusion. This ventral transverse muscle is continued for some distance backward as a powerful layer, and then a raphe appears in the mid-ventral line so as to form two muscles, each stretching from the common raphe externally to the ventral median line under the hypoderm, and this throughout the anterior region. In contraction they become almost baccate, especially toward the termination of the region. These muscles diminish immediately, so that in the tenth segment only their form is indicated by the small swellings on the band between the ventral longitudinal muscles. Finally, the chitinoid band which alone represents them separates the ventral vessel from the nerve-cords, and externally gives attachment to the vertical and oblique muscles. This double-bellied condition of the atrophied remnant of the transverse muscle is continued to the posterior end of the worm.

With the diminution and atrophy of the transverse ventral muscles over the nerve-cords in the posterior region the vertical and oblique also coincide, so that by-and-by only a few slender fasciculi of each remain, stretched from the dorsal raphe in the case of the

vertical and the lateral wall in the oblique, to the atrophied transverse on each side of the ventral blood-vessel. Toward the extremity of the body, again, both become well developed, the oblique spreading from the outer part of the arch over the nerve-cords upward and outward in a fan-like manner to the body-wall, whilst the vertical extend from the median part of the arch outward and then upward to the exterior of the dorsal longitudinal muscles.

The alimentary apparatus of *Magelona* consists of mouth, pharynx, proboscis, œsophagus, stomach, and intestine. The buccal folds occupy a large area when the proboscis is thrust out, but the buccal glands are not extruded to any extent. The pharyngeal region has very prominent transverse rugæ on its inner surface dorsally, and is thrust into the proboscis in extreme protrusion. The proboscis forms a pinkish, distensible sac, which especially in partial protrusion often presents a most regularly rugose appearance, but which in complete expulsion has the form of a reddish apple marked with flattened ribs, which run from the deep dimple at the apex to the base. The muscular apparatus in connection with this organ is of a most complex character, so that by its agency the animal can bore almost continuously forward in the moist sand, and form a tunnel in which the more delicate posterior part reposes in safety. The contraction of the muscular anterior region of the body, and the relaxation of the retractor muscles of the organ cause the proboscis to yield readily to the powerful stream of blood that is sent against it from behind, and it smoothly unrolls outward from the transverse margin of the lower lip like a supple membrane, the pinkish colour of the blood shining through the translucent tissue. The extension goes on until the brownish mass of the pharyngeal region approaches the front of the first body-segment and sends the muscular coil into the base of the proboscis and partly under the long retractor on its way to the tip—like a plug—assisting to retain the blood therein, and giving solidity to the whole organ. Thus, in its progress forward, the flattened snout is thrust amongst the sand with an undulating and insinuating motion till it has advanced about its own length ; then the proboscis is ejected to its full extent like an india-rubber dilator, so as to make a suitable channel for the occupation of the body, while again pressing forward the exploratory snout. Then all the retractile arrangements are brought into play ; the fan-shaped vertical fibres pull in the basal (anterior) region, the short and long retractors act on the entire organ, and the withdrawal of the pharyngeal protrusion makes an open channel for the backward stream of blood which rushes into the vessels of the anterior region out of the returning organ, further constricted by its own circular muscular coat. These alternate protrusions and retractions are repeated at somewhat regular intervals, and continued for a long time. Moreover, an explanation is perhaps afforded of the fact that the annelid is partial to fine sand, seeing that the sharp fragments of coarse gravel and sand might injure either snout or proboscis, though the latter is specially protected by its chitinous investment. Puncture of the anterior region of the body so as to give exit to the blood interferes with the protrusion of the proboscis ; indeed, it is not generally thrust out after such an injury.

The exsertile pharyngeal region is followed by a mobile part of the alimentary canal, which undergoes considerable elongation when the former is thrust forward, but which is variously coiled in retraction. The region lined by the chitinous investment may be

regarded as œsophageal, whilst that having a smooth outline and internally granular glandular tissue projecting in conical elevations, which in section present a dendritic or radiated appearance, may be stomachal. At the ninth segment the circular muscular coat is much thickened, the basement-tissue increased, and the glandular lining more consistent. In the next region of the body the entire canal assumes the soft, greenish glandular condition characteristic of the intestine and its chloragogenous coat. It diminishes toward the tip of the tail and ends in a dorsal anus, the cilia in the terminal region being largely developed.

The circulation in *Magelona* is remarkable for the presence of pinkish corpuscles in the blood. Two dorsal vessels arise at the posterior end from a bifurcated ventral and pass forward, closely connected by a median raphe (Fig. 124) on the dorsal arch of the alimentary canal, receiving in each segment a large branch from the ventral and numerous twigs from the alimentary canal, till they reach the posterior part of the tenth segment. There the walls are supplied with a powerful muscular layer which enables them to perform the functions of contractile chambers or "hearts." These chambers dilate, and then by vigorous systole drive the blood forward in a swift stream along the single anterior dorsal vessel which terminates in a branch to each tentacle, the stream being sent into each simultaneously. The blood courses along the afferent trunk next the smooth margin of the organ, and enters an extensive series of rudimentary capillaries which join the afferent trunk. Toward the tip of the tentacle the afferent vessel breaks up into numerous branches which join to form the vein, which is larger than the afferent vessel and lies next the papillose border. The purified blood returning from the tentacles curves forward into the snout to the tip of the lateral muscles, and, bending round, constitutes the vein which returns the blood to the ventral system.

The lateral trunks—external and internal—spring from the returning cephalic vessels, and in the first segment of the body form numerous transverse anastomoses with each other, so that a great plexus exists in connection with the proboscidian system, and finally this *rete mirabile* terminates in the single ventral vessel of the ninth segment, the outer lateral, in bending inward to the median line, forming slight pouches or dilatations (analogous to those of the dorsal vessels) which pour the blood backward at short intervals and simultaneously with the forward jets of the dorsal "hearts." When the anterior region of the body is in repose it is difficult to say in what direction the current in these vessels proceeds. It seems to disappear in contraction through the transverse vessels, and does not go in a continuous stream backward. In ordinary circumstances a large current flows backward in the sheath of the dorsal vessel, and thus in the opposite direction to that in the vessel itself. The whole anterior region, indeed, is a great vascular plexus akin to that in the Nemerteans. By-and-by the external vessels disappear, and the internal lateral vessels unite to form the single median ventral trunk which terminates at the tail by bifurcating and turning upward to constitute the dorsal trunks.

The general arrangement of the circulation in the posterior region may be illustrated by the condition in the eighteenth segment of the region. A large vessel goes outward from the ventral trunk at each dissepiment and trends under the body-wall to the posterior part of the segment, thus necessarily passing the bristle-tuft. It then forms a loop, returns to the dissepiment, and bends inward to join the dorsal vessel. Under favourable circum-

stances a series of small branches are observed connecting the foregoing artery and vein. After the current goes on with rapidity, a large branch suddenly appears nearly opposite the bristle-tuft, and the blood turns backward to the large sacculated chamber. A retrograde movement next takes place in the anterior part of the vessel, so that the pouch is much distended. Then the chamber just mentioned contracts, driving the blood vigorously forward along the vein into the dorsal trunk. These stages are repeated at short intervals. A large branch of the artery joins the vein above and below the point at which the vessel to the sac comes off, and when the chamber is in process of distension by the backward current both pour their blood into its neck. This arrangement was noticed by Dr. Fritz Müller, and his figure, though incomplete and inverted, is interesting. Further, in each segment small branches proceed from the ventral to the alimentary wall, pass outward over it and then turn upward to join the dorsal trunks. These intestinal vessels branch and communicate with each other. No vessel enters the feet or lateral processes.

The blood forms a pale rose-pink fluid charged with minute corpuscles, which, after extrusion, group themselves in various masses. The majority of the globules are nearly equal, though there is considerable variety in this respect. They also exhibit molecular motions, and their outline is sometimes altered by pressure. Many are ovoid, some circular or irregularly rounded. If they are examined in the *liquor sanguinis*, as in a tentacle, many show a shining globule or pale nuclear structure in the centre. Besides the ordinary globules are other bodies, perhaps indicating the development of a globule inside a cell-wall. A minutely granular coagulum is also placed here and there amongst the corpuscles. The blood in the proboscis of a moribund specimen assumes a brownish-red, or by transmitted light a brownish-purple hue.

The perivisceral chamber can scarcely be said to be functional anteriorly, but behind the ninth segment the body-cavity is considerably altered and enlarged, being rounded in transverse section and containing the alimentary canal, and the dorsal and ventral blood-vessels. The same lining of cœlomic epithelium as in front is present. The chamber is divided into two by the median ligament attached to the blood-vessels dorsally and ventrally. The contained fluid is perfectly translucent, coagulable, and corpusculated. The corpuscles are not very numerous, are circular, oval, fusiform, or irregularly rounded, and besides are flattened. Though some small globules and granules occur, the corpuscles, as a rule, are larger than the blood-corpuscles, with which they cannot be confounded. They show no trace of striæ or granulations, only a slight cloudiness in their protoplasmic centres. In healthy animals they collect in considerable masses in certain parts of the posterior region, and their great size and translucency are striking. The notion that a corpusculated perivisceral fluid and non-corpusculated blood are the rule in the annelids does not hold in *Magelona*.

Certain authors—for example, Benham [1] (1896)—place *Magelona* under a separate family—Magelonidæ, but, so far as observed, it may be retained as a genus of the Spionidæ.

[1] 'Camb. Nat. Hist.,' vol. ii, p. 323.

1. Magelona papillicornis, *Fritz Müller*, 1858. Plate XC, fig. 6; Plate XCIII, figs. 4 and 5—young; Plate XCIV, fig. 17—young; Plate CI, figs. 2—2 *c*—anterior region and feet; Plate CVI, figs. 7—7 *h*—bristles and hooks.

Specific Characters.—Head (prostomium) a large, flattened and somewhat ovoid muscular plate marked marginally by anastomosing vessels and forming a roof to the peristomial segment beneath it. Mouth opens ventrally, and the proboscis can be extruded as a mushroom-shaped organ. Tentacles long, with large papillæ on the distal two-thirds, and non-caducous. Touches of dark pigment occur as bars on them. Body 6—7 inches in length, apparently of two well-marked regions, the anterior short, of eight segments, and the posterior of more than a hundred, but the peculiar ninth segment really indicates a third region. It is somewhat quadrangular in section throughout. The first region has eight segments, narrowed behind, and marked by a dorsal and a ventral longitudinal band; the ninth segment is remarkably narrow. The third region is larger than the first, continues of considerable breadth for some distance, and then gradually tapers to the tail, which ends in a rounded border, the anus being within it, and with a short subulate cirrus on each side. The lateral regions of the greater part of the third division of the body are modified. The dorsal lamellæ of the first region are scoop-shaped, and the ventral are similar though smaller. The bristles are capillary. The bristles of the ninth segment are shaped like a mace with a process at the tip, and differ from all the others as do the lamellæ. The third or posterior region has in each foot a row of winged hooks dorsally, and another ventrally at the edge of the quadrangular body, whilst the somewhat ovate lamellæ are between them.

Synonyms.

1858. *Magelona papillicornis,* F. Müller. Arch. f. Naturges., Bd. xxiv, p. 216.
1865. *Mœa mirabilis,* Carrington. Annel. Southport, p. 9.
„ „ „ Johnston. Cat. Worms Brit. Mus., p. 278.
„ *Magelona papillicornis,* De Quatrefages. Annel., t. ii, p. 290.
1874. *Mea mirabilis,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 202.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 126.
1878. *Magelona papillicornis,* idem. Zeitschr. f. wiss. Zool., Bd. xxxi, p. 401, pl. xxix—xxxviii.
1879. „ „ idem. Journ. Anat. and Physiol., vol. xiii, p. 331.
1883. *Prionospio tenuis,* Fewkes. Bull. Mus. Comp. Zool., vol. xi, p. 167, pl. i, figs. 1—13.
1886. *Magelona papillicornis,* Giard. Bull. Sc. Fr. Belg., 2e sér., t. ix, p. 98.
„ *Mea mirabilis,* Harvey Gibson. First Rep. Fauna Liverp. Bay, p. 155.
1888. *Magelona papillicornis,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 642, pl. xxxviii, fig. 6.
1890. *Magelona papillicornis,* Malaquin. Annél. Boulonn., p. 47.
1891. „ „ Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 255.
1893. „ „ Lo Bianco. Atti Accad. Sc. Nap., ser. 2, t. v, p. 34, pl. iii, fig. 2.
1894. „ „ De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 83, pl. iv, fig. 104.

1894. *Magelona papillicornis,* McIntosh. Quart. Journ. Micr. Sci., vol. xxxvi, N.S., p. 76, pl. viii, figs. 1—3.
1896. „ F. Buchanan. Rep. Brit. Assoc. for 1895, p. 469.
1896. „ *papillicornis,* Benham. Quart. Journ. Micr. Sci., vol. xxxix, N.S., No. 153, p. 2.
„ „ „ Mesnil. Bull. sc. Fr. Belg., t. xxix, p. 257, pl. xiv, figs. 27—33.
1898. „ „ De St. Joseph. Ann. Sc. nat., 8e ser., t. v, p. 354, pl. xx, f. 166.
1904. „ „ Allen. Journ. M. B. A., vol. vii, N.S., p. 228.
1907. „ „ Percy Moore. Proc. Acad. Nat. Sc. Philad., vol. lix, p. 204.
1909. „ „ Fauvel. Bull. Inst. Ocean., 142, p. 5.
„ „ „ Lo Bianco. Mitt. Zool. St. Neap., Bd. xix, p. 581.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1911. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 417.
1914. „ „ Southern. Proc. Roy. Irish Acad , vol. xxxi, no. 47, p. 105.

Habitat.—Southport sands near low water (Dr. Carrington and W. C. M.) ; in sand at extreme low water, St. Andrews, in abundance, and also dredged off the East Rocks on a bottom—where *Lanice conchilega* abounds. At Southport not only that species, but *Owenia fusiformis* and *Valencinia armandi* accompanied it. Plymouth (F. Buchanan and Allen) ; Torquay (Elwes) ; Blacksod Bay (Southern). It is probably generally distributed around our shores in suitable localities.

Abroad it has been obtained in the Island of St. Catherine, Brazil (Fritz Müller) ; Channel shores of France (Claparède, Giard, Mesnil, and De St. Joseph) ; America ? (Webster and Benedict).

Head (Plate XC, fig. 6 ; and Plate CI, fig. 2) spatulate, very much flattened from above downward and thinned at the edges, which are marked by a beautiful series of somewhat radiate pale lines, which anastomose with each other at the free border. Two strong muscular bands proceed from the tip of the snout backward along the centre, the outer being mainly longitudinal, though distinct transverse fibres are present, and pass the mouth. The fibres of the inner band on each side are directed inward anteriorly, forming long oblique fascicles, but toward the mouth the obliquity is much greater, though the direction is the same, viz. backward and inward. A large blood-vessel—appearing in some cases double—runs forward between the outer and inner bands. The tissue between the meshes of the blood-vessels at the margins of the snout is cellulo-granular—probably mainly hypodermic.

This great flattened ovate snout continues backward to form a roof or shield to the peristomial segment beneath it, a condition by no means common in the group, yet it would appear to be a modification of the prostomium observed in *Polydora* and other Spionidæ.

The tentacles spring from the peristomium considerably in front of its posterior border and beneath it, and are remarkable organs of great length. The papillæ are arranged in a double row. No cilia occur on them.

The mouth opens on the ventral surface, also in front of the posterior border of the dorsal plate of the prostomium. From the mouth projects in many preparations the more or less rounded mass of the proboscis, which at intervals, moreover, is thrust out in the living form, and the organ has a series of regular frill-like striations. In the gut are mud and diatoms.

The body extends to 6—7 inches, or even more in length, and consists of two well-

marked regions, viz. an anterior with eight pairs of bristle-bundles, a ninth segment *sui generis*, and a succeeding elongated part composed of a peculiar ninth series of bristles, the rest having a widely separated dorsal division bearing capillary bristles, and a ventral division carrying hooks. Segments 145, and in its native sites the body is extremely elongated and ends in a rounded tip and two short, subulate caudal cirri at the anus.

The general colour anteriorly ("thoracic" region) is a beautiful pale pink, the long tentacles being of the same hue. The succeeding region of the body is dull greyish or greenish from the intestine. The sides of the body have whitish pigment chiefly developed at the segment-junctions between the bristle-tufts. Ventral surface pinkish, this colour being due to the tint of the blood, which also colours the extruded proboscis of a deep pinkish hue. The tentacles are sometimes banded with black, the pigment occurring on the ventral surface nearly from side to side along the distal two-thirds—that is, in the region of the papillæ.

The first region of the body (Plate CI, fig. 2) has eight bristled segments, and it is characterised not only by its colour and smoothness, but by the somewhat quadrangular outline. On the dorsal surface a distinct median fillet from the muscles (?) occurs, whilst ventrally a broad area with a raised lateral margin passes from the rear of the mouth to the end of the region, and in the last segment it narrows to its termination. The region itself is distinctly constricted posteriorly.

The first pair of feet are somewhat in front of the median posterior peak of the prostomium.

The anterior bristles form a double series in each foot. The inferior are simple, delicate, and tapering (Plate CVI, fig. 7), and such have a larger free portion and a more pronounced terminal curve than the more numerous superior series (Plate CVI, fig. 7 *a*). Both have wings, which, however, are wider in the superior bristles. The dorsal lamella of an anterior foot is shown in Plate CI, fig. 2 *a*, and the ventral lamella in Fig. 2 *b*.

Mesnil's interpretation and figure of the fifth foot differs from the condition in the St. Andrews and other examples observed. He describes a dorsal and a ventral subulate cirrus in addition to the dorsal and ventral lamellæ; broken fragments of lamellæ and folds of these peculiar structures simulate cirri, but that is all that can be said. No structure of that kind has been observed. Moreover, he states that the bases of the dorsal and ventral bristles are enveloped by the respective lamellæ-like sheaths (*d'une sorte de fourreau*). This appears to be a misinterpretation of the able French observer. The bristles are never included between the flaps of the lamellæ, but are outside these, viz. in front of them, as can be seen in detached feet by focussing, and *in situ* under a low power.

Mesnil states that the ventral division of the eighth foot differs from all those in front of it by its great development, but it can only be said that this organ slightly increases from before backward, the seventh being nearly as large. It is probable that he has mistaken the dorsal for the ventral, for the dorsal is the larger, in the form of a scoop-shaped lamella with a larger tuft of the capillary bristles in front; whereas the ventral scoop-like lamella is smaller, with a somewhat smaller (not shorter) group of bristles.

The second region of the body is formed by the ninth segment and its feet with their special arrangement. Dorsally is a fan-shaped lamella with a truncated tip bearing a

series of delicate flattened bristles, each with an expanded translucent tip rounded at the edges (Plate CVI, figs. 7 *b*, 7 *c*, 7 *d*, and 7 *e*), and distally with a short prong. The shaft of the bristle is marked by a line which disappears at the enlarged end near which the shaft is curved. This line or ridge may indicate modification of a winged bristle, of which the rounded tip is an expansion, and various degrees of development may be traced. Thus the dilatation at the tip is comparatively slight in those (Plate CVI, fig. 7 *b*) next the few simple bristles; then a larger tip is found (Plate CVI, fig. 7 *c*), followed by the well-marked series (Plate CVI, figs. 7 *d* and 7 *e*) in which the shaft tapers to a fine point near the tip, whilst the broad wings continue and coalesce into a translucent expansion with the terminal filiform process. In the dorsal group there is only a tendency to the formation of the simple bristles at each end of the row, the rest leading to those with the spatulate translucent tips. Amongst them are some longer forms, also translucent, each having the aspect of a shortened and widened capillary bristle, with double translucent wing, a double curve, and a tapered tip, but less tapered and broader than the tips of the anterior series. Intermediate forms also occur with a somewhat widened tip and a longer central axis or prong.

The two dorsal lamellæ approach each other closely in the middle line, thus differing from the feet of the anterior and posterior regions.

The ventral division of the ninth foot forms a transversely elongated fan-like lamella stretching inward across the body. It bears the same remarkable bristles, and, in addition, a group of about three long, slender capillary bristles with traces of wings at the tip. These have not been observed by Mesnil. The two ventral lamellæ are separated by a considerably larger median gap than the dorsal. The segment to which these bristles belong seems to have atrophied, that is to say, it is represented only by the attached surface of the lamellæ.

The ninth segment indicates a distinct region, and its bristles would appear to be homologous with the special forms in the third segment of *Disoma*, the fourth in the Chætopteridæ, and the fifth in *Polydora*, and probably are of service in protruding the anterior region from the sand into the surrounding water for aëration and food, as well as forming a special fulcrum during the movements of the snout and the anterior region in boring.

The tenth foot presents two broadly ovate lateral lamellæ with narrower attachments, which are situate between the processes bearing the winged hooks.[1] The dorsal process forms a thin lamella broader at its outer margin and running to the surface of the body at its inner edge. It carries about a dozen hooks, with the points of the main fang directed outward (Plate CVI, figs. 7 *f*, 7 *g*, and 7 *h*). The ventral process has much less depth and is shorter, and soon reaches the surface internally, a small conical cirrus marking its inner edge. The position of the respective parts is thus in keeping with their functions. The prominence of the winged hooks dorsally and ventrally places them in ready touch with the wall of the sand-tunnel, whilst the delicate lamellæ can be folded flatly against the lateral wall between them. De St. Joseph states that the tenth segment and the following are biannulate, the posterior one bearing the feet.

[1] Mesnil observes that the external part of the winged hook in this form and in the young *Nerine cirratulus* is paired, but what is probably meant is that the wing is double.

Mesnil thinks that the "cirrus" is likewise present in the second region of the body, dorsally and ventrally. No proof of this has yet been obtained at St. Andrews. He also observes that the spike on the crown of the hook is double, and that he has only seen this in the young of *Nerine cirratulus*.

In the posterior region of the body, in which the feet have the structure indicated in Plate CI, fig. 2 *c*, a tuft of simple curved bristles occurs as a kind of support to each pillar of the lateral lamellæ. Moreover, a very fine tuft of slender hair-like bristles, only observed on careful examination of the living animal, projects behind the pedicle of the lamella. It is difficult to believe that such are the tips of the simple curved bristles, but no others can be seen in the mounted preparations. Such are probably homologous with the curious hidden bristles (spicular or asbestos-like) in *Polydora*.

On the sides of the posterior region, from the twenty-fifth or twenty-sixth segment backward, are the peculiar glandular organs (pouch-like) which occupy the lateral region of each segment.

In the first region of the body the setigerous processes are situated at the extreme front of each segment; the ninth series occupies a prominent ridge near the middle of this short segment. In the posterior region the hooks are placed at first toward the anterior margin of the segment, thereafter they gradually pass backward till they reach the postero-lateral border of each segment.

Habits.—It lives in a simple straight burrow in the sand at extreme low water, but it does not occur in coarse or "troubled" sand at St. Andrews. When free it can float on the surface of the water. No special tube seems to be formed by the animal under ordinary circumstances—simply a tunnel in the sand. If after capture it is placed in a vessel with a little sand, a coating is sometimes made and in others a complete tube of sand, probably to compensate for the absence of its element.

Reproduction.—Lo Bianco (1909) gives the period of sexual maturity at Naples as from December to July. Females are loaded with ova and males with sperms at St. Andrews in June.

It is remarkable that a form having a structure so complex and so peculiar should be widely distributed over the globe.

Claparède[1] (1863) describes the development of this form, his earliest stage having about twenty closely arranged segments. Like many Spionid larvæ it is widest anteriorly and tapers to the posterior end. The cephalic region forms a wide cup with a notch inferiorly, and it is richly ciliated. The first pair of setigerous processes bears long slender bristles which stretch almost to the posterior end. The rest carry only a band of cilia, and at each side a small pigment-spot. The alimentary canal is complete.

In the next stage a short conical snout with two eyes appears, and two short tentacles with ridges near the tip. The long first bristles are still present, but eight anterior segments now have tufts of provisional bristles, whilst those behind are marked by a yellowish-brown pigment-bar.

In his latest stage the tentacles are long and coiled, and besides the basal bars have long slender papillæ. The short snout has four reddish eyes in a transverse row. The œsophagus is differentiated by a crenated pigmented band on each side posteriorly.

[1] 'Beobacht. Anat. Entwickl.,' p. 74, Taf. x, figs. 9—14, Taf. xi, figs. 1—2.

Besides the two conspicuous tufts of long, provisional bristles in front, there are four considerable tufts of transparent bristles in the middle of the body. The terminal region is simply rounded and pigmented, and a band or a touch of pigment at each side indicates the other segments.

Dr. Fritz Müller,[1] in 1858, in his observations on the annelids from the Island of St. Catherine, off the coast of Brazil, briefly mentions this remarkable form. The type was next referred to by Dr. Edouard Claparède[2] in his account of a larval form which he found at St. Vaast-la-Hougue, on the west coast of France. The same singular species, however, as that indicated by the first-mentioned author was originally discriminated by the late Dr. George Johnston,[3] of Berwick, from preparations forwarded by the distinguished botanist, Dr. Greville, but as his description was not published until 1865, long after his death, the name (*Mæa mirabilis*) which he gave lapses.

Young stages of this form were described by W. Fewkes[4] (1866) as larval forms of *Prionospio*, but, as Giard[5] has shown, they are referable to this species.

Lo Bianco's figure (1893)[6] of the anterior region presents an injured abnormally contracted snout, and the structure of the tentacles is indistinct.

Between May and October various stages of the larval and post-larval *Magelona* are procured in the tow-nets in St. Andrews Bay, and two of these are described and figured elsewhere.[7]

Mesnil (1896) considers that *Magelona* has two important characters of the Spionidæ, viz. those of its tentacles and its winged hooks. Its aberrant characters are :—

(1) The form of its prostomium; (2) the presence of two vessels in its tentacles, and the absence of a ciliated line along these organs; (3) the division of the body into two distinct regions. The other aberrant character is the absence of branchiæ. It approaches *Spiophanes* by the long and fine lamellæ of the feet. He thinks it interesting in regard to the evolution of the Chætopteridæ, especially in connection with the distinct regions of the body, but this is doubtful. The feet in the ninth setigerous segment resemble those of the second, and the form of the feet of the eighth is intermediate between that of the seventh and the ninth. A survey of the structure of the Chætopterids, however, shows that there is no continuity of the families.

Mesnil is of opinion that the embryology of *Magelona* confirms the Spionid relationships. He can verify the exactitude of the figures of Claparède, Fewkes, and McIntosh. In the larva the prostomium is short, and bears four eyes. The winged hooks are found in a larva of thirty segments. In the tenth one winged hook occurred ventrally, and in the fourteenth two dorsally. Claparède again found six eminences at the anus indicating six cirri. The larva differs from that of other Spionids in the great develop-

[1] 'Arch. f. Naturges.,' 1858, p. 211.
[2] 'Beobacht. Anat.,' etc., 1863.
[3] 'Cat. Worms Brit. Mus.,' p. 278.
[4] 'Annals Lyceum Nat. Hist. New York,' vol. viii, p. 320, pl. vii, fig. 19.
[5] 'Bull. sc. Fr. et Belg.,' t. xvii, p. 98, and 'Œuvres Div.,' p. 192.
[6] 'Atti R. Accad. Sc. Nap.,' ser. 2, vol. v, Tav. iii, fig. 2.
[7] 'Quart. Journ. Micr. Sci.,' vol. xxxvi, N.S., p. 68, pl. viii, figs. 1—3.

ment of its pharynx with its two opaque glands posteriorly. The dorsal vessel in the anterior region is very large; the blood is driven forward by a veritable heart at the limits of the fifth and sixth setigerous segments. Dorsally the larva has reddish-brown pigment; cilia exist on the epaulettes, which support the long bristles of the first segment, on the fifth laterally, and a few on each segment of the posterior region. The digestive tube has, in the posterior region, a border of creamy white. The provisional bristles are not winged, nor crenulate, but absolutely smooth.

An interesting contribution to the nature of the blood in *Magelona* was published (1886) by Prof. Benham[1] mainly from observations at St. Andrews. In this the author thinks the blood different from that of any other Chætopod, and that the rose-coloured globules are non-nucleated, though isolated nuclei occur in the scanty colourless plasma, which is coloured red by hæmoglobin. He compares these coloured globules with the coloured plasma of ordinary Chætopod blood rather than with the coloured corpuscles of the cœlom in *Capitella*, *Glycera*, and *Polycirrus*.

Ray Lankester[2] (1900), again, considers the condition in *Magelona* as an advanced case of phlebœdesis "which almost extinguishes the cœlomic cavity."

Häcker[3] (1898) figures (Fig. C) an early stage of *Magelona* with two long tentacles, and a still longer tuft of swimming bristles, at each side of the head, which remains short.

The *Magelona*-larva described and figured by this author[4] (1898) from the Cape Verde Islands, differs from the ordinary type in regard to the structure of the body and the enlargements of the tentacles, as well as in their great proportional length and structure at that stage. The author rightly calls it a *Magelona*-like larva, and it is possible that it pertains to another genus of Spionids.

The able French author, Gravier[5] (1906), describes a species, *Magelona obokensis*, from the Red Sea, which offers so few differences—the presence of several rows of papillæ on the tentacles being one of these—that possibly future observations and the occurrence of intermediate forms may tone down the distinctions, though a papilla above the seventh foot has not been observed in the British form.[6]

Genus CV.—Streblospio, *Webster*, 1880.

Prostomium well developed (elliptical or conical) and bearing four eyes. Two ciliated cephalic tentacles. A single pair of large dorsal branchiæ from the first setigerous segment. Ventral region of the peristomium prolonged forward like a collar. Body cylindrical, of two regions, anterior and posterior, but they are little differentiated. Bristles and ventral hooks from the eighth or ninth segment. No anal cirri.

The genus *Streblospio* was established in 1880 by Webster[7] for a small annelid from

[1] 'Quart. Journ. Micr. Sci.,' vol. xxxix, n.s., p. 3, pl. i.

[2] 'Treatise on Zool.,' pt. 2, p. 27.

[3] 'Biol. Centralblatt.,' Bd. xviii, pp. 41 and 42.

[4] 'Plankton Exped.,' p. 20, Taf. ii, figs. 19—20 *a*.

[5] 'Nouv. Archives du Muséum,' Paris, t. viii, p. 163, pl. ii, figs. 186—192.

[6] Mr. Southern has found J. P. Moore's *Magelona rosea* on the west coast of Ireland.

[7] 'Rep. Fish and Fisheries, U. S. A.,' p. 129, pl. v, figs. 48—50, 1880.

the coast of New Jersey. He and Benedict[1] also described this and a new form in 1884. It is doubtful, however, if the second form pertains to the same genus as the first.

1. Streblospio Shrubsolii, *Buchanan*, 1890.—Plate LXXXIX, fig. 7; Plate CIV, fig. 10—hook.

Specific characters.—Snout forming a bluntly-conical process bearing four eyes. At its base are a pair of ciliated tentacles, whilst from the dorsum of the first segment are the longer branchiæ. Body minute, 6—10 mm. in length, of thirty to forty-eight segments, nearly cylindrical, only tapering a little toward the somewhat blunt posterior end. Little differentiation into anterior and posterior regions except as regards bristles. It terminates posteriorly in a truncated extremity on which is the anus. Feet indicated only by small lamellæ behind the bristle-bundles, the dorsal being a little above the bristles and the ventral a little below them. Bristles winged and capillary anteriorly, and the same forms occur dorsally throughout. Ventrally the winged hooks commence on the eighth segment, but capillary forms accompany them in diminishing numbers to the posterior end. Two green nephridia anteriorly. An inhabitant of mud.

Synonym.

1890. *Hekaterobranchus Shrubsolii*, F. Buchanan. Quart. Journ. Micr. Sci., vol. xxxi, n.s., pp. 175—200, pls. xxi and xxii.

Habitat.—In soft mud usually covered by about an inch of water at Sheppey, and extending so far up as Gravesend on the south side of the river Thames. It is associated with *Haplobranchus*, *Nais*, *Hemitubifex*, nematodes, and planarians (Florence Buchanan).

The *head* (Plate LXXXIX, fig. 7) resembles that of a Spionid, for it is bluntly conical and bears four eyes, the two posterior wider apart. Occasionally additional eye-specks occur. A pair of crenated ciliated "tentacles" (Buchanan) arise from the base of the prostomium, the ridges carrying the cilia, the effect being heightened by the yellowish-green transverse streaks. They are hollow, for a process of the cœlom enters them, and also a contractile blood-vessel. They are bent forward in search of food, the minute particles of which (*e. g.* Infusoria) are carried by the cilia to the mouth, which is on the ventral surface of the peristomium.

On the dorsum of the peristomial segment is a pair of branchiæ, which are longer than the tentacles, and of a reddish-orange colour, mainly due to a vascular loop. They have shorter cilia than the tentacles, and at the base of each is a tuft of three short capillary bristles, whilst a little behind and beneath is the ventral tuft with a lamella below it. The body of the first segment reaches further forward ventrally than dorsally, and thus makes a kind of collar (Buchanan). So far as can be judged from Miss Buchanan's description and figures it is possible that the bristled segment is the first body-segment, the peristomium being in front of it. The body is from 6—10 mm. in length, nearly cylindrical throughout the greater part of its length, and only tapered a little toward the tail, which is by no means attenuate. In section it has a slightly flattened curve dorsally and ventrally in the "thoracic" region, the lateral outline is

[1] 'Rep. Fish and Fisheries U.S.A.,' pp. 728—729, pl. v, figs. 60—64, and pl. vi, figs. 65—72, 1881.

shorter and more irregular from the lamellæ. A similar outline characterises the anterior "abdominal" region, but it is more rounded posteriorly (Fig. 124*a*). The first bristled segment, already described, has shorter bristles than the succeeding, which, to the number of seven, have capillary bristles both dorsally and ventrally. Each has behind it the membranous lamella. The winged hooks (Plate CIV, fig. 10) commence in the ventral division at the eighth segment, a few capillary bristles accompanying them, and they continue to the posterior end, the accompanying bristles becoming fewer. On the dorsum of the second segment is a peculiar "dorsal collar" resembling a modified dorsal lamella.

The body-wall consists of cuticle, hypoderm, mucous glands, circular muscular fibres, two dorsal and two ventral longitudinal muscles, the inner surface being lined with cœlomic epithelium.

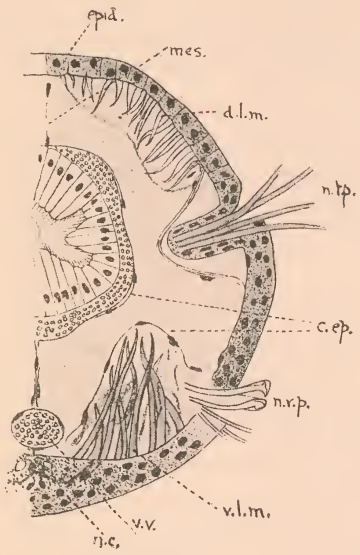

Fig. 124*a*.—Half section of the body-wall of *Streblospio* through the posterior abdominal region, after Miss Florence Buchanan. *mes.* Dorsal mesentery; *c.ep.* cœlomic epithelium.

The alimentary canal presents a short protrusible and ciliated pharynx, behind which is a narrow œsophagus, a wider region, and then the moniliform intestine which ends in the anus. The terminal region of the gut is ciliated and may be respiratory. The wall of the canal has from without inward cœlomic epithelium, circular muscular fibres, and cylindrical epithelium. Gregarines (*Monocystis*) are common in the intestine.

The vascular system consists of a dorsal trunk, which gives off at the posterior border of the prostomium a branchial vessel on each side, the returning trunk passing to the ventral region to meet its fellow of the opposite side to form the ventral vessel. Before they meet each is joined by the single trunk from the tentacle. The ventral vessel reaches the posterior end and enters the sinus surrounding the intestine. Miss Buchanan thought that a ridge on the dorsal wall of the intestine surrounded by the sinus represented, perhaps, the heart-body in other Polychæta, but this is uncertain. The blood goes from behind forward in the dorsal vessel and in the sinus, which extends from the posterior region to the anterior third; from before backward in the ventral vessel. Dorso-ventral vessels in the anterior region of the body connect the main trunks. Two kinds of segmental organs (nephridia) occur. The first are two green tubes forming

a loop in the anterior region, and which open externally between the second and third bristle-bundles, apparently at the posterior part of the second segment. The exact situation of the inner opening is uncertain. In ripe forms simple, clavate, ciliated tubes are found in those segments having gonads. Further investigation is needed as to their history. The series are separate. The sexual elements appear to be developed in the posterior segments. The nerve-cords present a neural canal at the upper and inner region of each in section (Fig. 124 *a*).

Habits.—It is less hardy than *Haplobranchus*, and apparently less able to live in brackish water diluted by heavy rain-showers. It is recognised by its vermiform movements, its red colour, and the waving tentacles.

It forms a loosely coherent tube by gathering up particles of mud around it, probably by aid of mucous glands.

Spionid Z, with horny proboscis. Plate CV, figs. 5 and 5*a*—bristle and hook.

A crushed fragment of what appears to be a representative of this family or allied to it, was procured by Dr. Gwyn Jeffreys in the 'Triton' in 1883. Locality not stated, but probably in deep water in the Atlantic. It has the peculiarity of a horny wall to the proboscis.

The foot in the dorsal division bears tufts of pale golden, nearly straight, capillary bristles of considerable length, finely tapered almost from the basal third to the tip, and marked by longitudinal striæ (Plate CV, fig. 5). The inferior division has ventrally two or three long, curved dotted bristles, and a series of winged hooks (Plate CV, fig. 5 *a*) with narrow necks and the wings truncated at the tip. The main fang seems to be grooved or striated, and with a well-marked spike on the crown in lateral view. The length and slenderness of the shaft of these hooks differ considerably from the ordinary type of the Spionids, and the position here assigned to the fragment is quite provisional.

The example is a female with partially developed ova.

Genus CVI.—Pœcilochætus, *Claparède*, 1863.

Prostomium simple, with one anterior median tentacle. Nuchal organ in the form of three tentacle-like processes arising from the posterior border of the region. Dorsal cirrus of the first segment well-developed, ventral rudimentary. Both cirri from the seventh to the eleventh (or thirteenth) segment flask-shaped, with long stiff necks. Anus dorsal, with two long and two short cirri. Branchiæ on the feet from the twenty-first segment backward. Dorsal blood-vessel with large lateral pouches in segments twelve to fifteen. Bristles from the seventeenth segment backward have long hairs. In the posterior region the dorsal bristles have assumed the form of stout hooks in transverse rows.

This genus owes its origin to the acuteness of Claparède,[1] who in 1863 found many

[1] 'Beobacht.,' p. 77, Taf. vi, figs. 1—11, 1863.

examples of a pelagic larva off the coast of Normandy, a larva he had previously met with on the coast of Norway in 1855. Though he did not assign a name to it, his experience enabled him to recognise certain fragments procured in the 'Lightning' Expedition as pertaining to the adult form of the larva formerly mentioned. Ehlers,[1] who included Claparède's account at the commencement of his paper on the annelids of the 'Porcupine' below 500 fathoms, also makes remarks with figures, on two specimens of the same form. Claparède thought that it could not be included in any known family, and he called it *Pœcilochætus fulgoris*.

Levinsen[2] (1883), who had examined the larval stages from the Skager Rak, showed that *Pœcilochætus* was closely allied to *Disoma*, Œrsted, and he ranged both under the Spionidæ.

The larval form was found generally in the tow-nets in St. Andrews Bay from July to October,[3] showing that the adults could not be far removed, yet up to date not a single adult has been captured. Nothing can better illustrate the safety of many forms, even so high as fishes, in the sea.

1. Pœcilochætus serpens, *Allen*, 1904. Plate XCII, fig. 4; Plate XCIV, figs. 15 and 15 *a*; Plate CI, figs. 3 and 3 *a*—head and tail; Plate CVII, fig. 17—bristle; Plate CXI, figs. 11—11 *e*—bristles and hook.

Specific characters.—Nuchal organ greatly developed in the form of three long tentacle-like processes. Anterior dorsal surface with few tubercles. Cirri of segments seven to thirteen different from the others, being flask-shaped, with long, stiff necks. Second and third segments have short, stout spines ventrally. Anterior region coloured red from the blood.

Synonyms.

1863. *Unbekanuten Rukenkiemer gehörigen Larve*, Claparède. Beobacht., p. 77, Taf. vi, figs. 1—11.
1904. *Pœcilochætus serpens*, Allen. Quart. Journ. Micr. Sc., vol. xlviii, n.s., p. 79, pls. 7—12.
" " " . Journ. M. B. A., vol. vii, p. 228.

Habitat.—In sand at Plymouth.

A considerable step in advance was made by the discovery of the adult form in tubes in sand at Plymouth, so that Dr. Allen was enabled to give a careful account of it with figures.[4]

The *head* (Plate XCII, fig. 4, and Plate CI, fig. 3) is small and hemispherical, bearing two small dorsal, and two larger ventral eyes, whilst beneath it is a short median minutely papillose tentacle, the base of which is within the mouth when the proboscis is withdrawn. The great lateral tentacles or palps arise immediately behind the head and extend to at

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xxv, pp. 2—13, (p. 62), 1875.
[2] 'Nat. For. Vid. Meddel.,' 1883, p. 103.
[3] 'Quart. Journ. Micr. Sc.,' vol. xxxvi, n.s., p. 71, pl. viii, figs. 4—7.
[4] Ibid., vol. xlviii, n.s., pp. 79—151, pls. vii—xii, 1904. Much of this account is taken from Dr. Allen's description.

least half the length of the body, slightly tapering at the distal extremity, and being horseshoe-shaped (from a groove) in transverse section. A single blood-vessel occurs in each, and probably, as in *Magelona*, they subserve respiration. From the posterior dorsal region three long brownish tentacles, viz. a median and two lateral, arise from a single broad base, and these are considered by Allen to be the nuchal organ.

The short proboscis with thick walls is generally retracted in preserved specimens, and behind the intestine is comparatively straight, but especially from segment sixteen backward it is dilated in every segment, and the pouches are constantly contracting, so that the circulation is thus aided. A deep ciliated groove occurs along the mid-ventral line of the intestine throughout.

Parasitic nematodes frequently occur encysted in the body-cavity.

In the anterior region (segments one to eleven) is a large muscular blood-vessel, the contractions of which are from behind forward, and from the third to the eleventh segment a lateral branch runs outward and downward on the posterior septum, then sends a twig to the foot, and, branching, one of the trunks divides into a number of blind finger-shaped processes in the segment behind. Anteriorly the dorsal vessel bifurcates, sending a large vessel to each palp which would appear to have a respiratory function. In the middle region of the body (segments twelve to fifteen) the dorsal trunk is much enlarged, with lateral pouches on each side, and the expansion and contraction of these is a conspicuous feature, valves occurring between each successive pair of pouches. In the posterior region the dorsal vessel can no longer be distinguished, but is merged in a sinus which surrounds the intestine, as in certain Oligochæts.

The *body* is long, about 55 mm. and having 110 segments, slender and cylindrical anteriorly, but diminishing a little posteriorly, as well as being flattened, a concavity, indeed, appearing dorsally; moreover, the dorsal cirri are only half the size of the ventral (which are nearly normal in size). The pygidium (Plate CI, fig. 3 *a*) has the anus dorsal in position in the midst of five lobes, and with a pair of long dorsal and a pair of short ventral cirri. The mouth is ventral in the midst of ridged lips. The proboscis is almost spherical, and covers the median tentacle on the base of its anterior wall.

The colour of the anterior region is bright scarlet or deep purple, according to the degree of aeration of the blood, the feet and cirri being colourless. The posterior region is dark green or white, the former colour being due to the intestinal cells, the latter to the male elements.

The first segment (peristomium) is largely developed, and bears a foot composed of fused dorsal and ventral divisions, the cirrus of the latter being large, flask-shaped, and directed forward, whilst that of the former is rudimentary. The bristles in each are simple, long, smooth, and curved inward, so that they often cross. Slight differences occur in these in regard to length and slenderness (Plate CV, fig. 18, and Plate CXI, fig. 11), and almost all are finely striated longitudinally throughout the greater part of their length, only the curved tip having a tendency to a finely granular centre. Small papillæ cover the feet and cirri, and at their ends are the openings of mucous glands. Between the dorsal and ventral cirri are small, projecting pear-shaped sense-lobes, with hairs projecting from a cup-like depression at the extremity.

In the second segment the dorsal cirrus is well developed, and the intermediate sense-

organ is present (Plate CXI, fig. 11 *a sp.*). The dorsal bristles are long, slender, and simple, but one is provided with rows of short spines directed distally. The ventral have the form of three or four short, stout, slightly-curved hooks (Plate CXI, fig. 11 *a*), which have a slight forward curve above the base, then a slight dilatation in some below the forward curve of the hooked tip. They are striated longitudinally at the base, and obliquely below the clear tip, which is by no means sharp, though boldly curved. The dorsal division has very fine simple bristles, which are much more slender and translucent than those on the first foot.

In the third segment the cirri are smaller and more conical. The dorsal bristles are long, simple, and smooth; the ventral consist of three well-developed stout hooks, and one rudimentary hook.

The cirri of the fourth segment are somewhat less than in the third, stretch outward or slightly backward, and the bristles of both divisions are now similar, viz. straight smooth bristles. The fifth foot differs in having short dorsal cirri and long, slender ventral cirri (the longest behind the first), and they are often arched over the back. The sixth segment resembles the fourth, the bristles from the third to the sixth being all smooth, and thus differentiate the anterior region. The seventh commences a region extending to the thirteenth, with flask-shaped cirri, which, moreover, are stiff. The bristles are of two kinds, smooth, slender forms, and a few spinous bristles. Lateral sense-organs, as in front, also occur, but they are broader. In segments fourteen to sixteen the feet rather resemble those found in the fourth and sixth segments. The bristles are similar to those just mentioned. The dorsal and ventral cirri, now conical in shape, diminish considerably at the seventeenth segment, and continue of similar character to the thirtieth segment from the tip of the tail, though variation in individual segments occurs. The bristles, however, are remarkably developed, the slender forms of the anterior segments being replaced by large, hairy, feather-like bristles (Plate CXI, fig. 11 *d*), the dorsal and ventral in each tuft being the stronger, whilst the inner are more slender and flexible, but have much longer secondary hairs, as in Plate CXI, fig. 11 *c*. The pinnate bristles also have more slender shafts, the lateral hairs are longer, and Dr. Allen thought the latter were connected to the shaft by a transparent membrane, but it may be mucous. These bristles aid in making the current of water, which is drawn through the U-shaped tube. About the twentieth foot another bristle (Plate CXI, fig. 11 *e*) is present, characterised by its soft or membranous spine-like processes. The lateral sense-organs form a depression, surrounded by a circular rim, the sensory hairs arising from the centre.

The last sixteen or seventeen segments are somewhat flattened, and the dorsal surface is slightly concave, and, whilst the shape is normal, the ventral cirri are about double the size of the dorsal, which also are more dorsal in position. The bristles, moreover, have been transformed into strong hooks (Plate CXI, fig. 11 *b*), which form a transverse row on either side with the concavity of the hook posterior, so that they would fix the annelid securely in its tube, as well as perform other functions. The other bristles in these segments are either of the ordinary smooth or spiny kind; but in the terminal region (about the thirtieth segment from the end to the tenth) is a peculiar form (Plate CVII, fig. 17) somewhat resembling forms seen in *Eupanthalis*, the terminal portion of the bristle forming a kind of flexible process or brush. The lateral sense-organs are again pear-

shaped papillæ. The dorsal and ventral surfaces of the body, and the cirri of this region, are covered with papillæ, the epithelial glands opening at their ends.

The ventral nerve-cord shows two large neural canals, and externally it has only the hypoderm and cuticle. Allen describes the broad basal posterior cephalic region and the three tentacle-like processes as representing the nuchal organ, the whole being covered with sensory hairs. The lateral sensory organs have special ganglion-cells.

The gills commence on the twenty-first segment and continue nearly to the posterior end. The filaments are at first short, but soon become long, as long, or longer than the cirri, and bright red. Two pairs occur on the posterior surface of each foot, one dorsal the other ventral.

The nephridia form short greenish-brown tubes in each segment, those in front opening by ciliated funnels to the segment anterior to them, whilst from segment seventeen backward nephridia (nephromixia, Goodrich), with large genital funnels attached, occur.

Reproduction.—The precise date at which the genital products ripen is not noted by Allen, but it is probably in February and spring. They are found from the seventeenth segment backward. The ova are lenticular in shape with a vesicular margin as in certain Spionids, *e. g. Spiophanes*, and the surface has raised lines. The sperms occur in the males in similar parts of the body.

In his ' Beobachtungen ' Claparède (1863) gave an account of an unknown, translucent larval annelid which he had first found in 1855 at Christiansand, on the Norwegian coast. It was common on the tow-nets at St. Vaast la Hougue. His earliest stage had from fifteen to sixteen segments. The head dorsally showed two rounded bosses in front and a collar or border behind, with long cilia, four long palpocils in front, and four eyes, the anterior pair more widely separated. The first foot was largely developed, with a tuft of longer bristles than the succeeding, but the nine following also had bristles, and a brownish pigment-speck. The mouth formed a tranverse slit on the ventral surface, and the alimentary canal was moniliform behind the first bristled segment. A thickened rim and a circle of long cilia terminated the body posteriorly.

His next stage had from eighteen to twenty-four segments, biramous feet, and a pair of tentacles on the head. ' When the larval annelid had attained the length of 3 mm., it had from thirty to fifty segments. The blunt head had four eyes, a dorsal fold on each side, and two short tentacles. The first foot was biramous and had the long glassy bristles, and the succeeding feet were also biramous, a lanceolate outline characterising the lobes in those after the tenth or thereabout. The dorsal provisional bristles were slender, but the ventral were stouter, and marked by minute conical spikes, like certain sponge-spicules. A pigment-speck between the lobes of the feet in the translucent annelid is a conspicuous feature in these stages.

In his latest stage the chief changes were the development of brownish pigment in the dorsal lamellæ of the feet and the occurrence of long processes like Indian clubs instead of the usual lamellæ on the seventh and four following feet. There was little change in the head, which had its four eyes and two tentacles. In his Norwegian example the first feet were close behind the head, and the œsophagus seemed to be longer, whilst in the second and third feet two slender curved papillæ occurred just in front of the space

between the divisions of the feet. It agreed with the other examples in having six bristled feet in front of those with the long club-shaped processes.

Claparède made comparisons of this unknown larva with *Polydora* and *Magelona*, but he did not definitely connect it with the Spionidæ.

The pelagic young of this form had long been known in the tow-nets at St. Andrews, yet up to date no adult example has ever been procured. An account of the various stages was given in 1894,[1] the youngest having about twelve bristled segments, and the most advanced about fifty segments. The long provisional bristles, the feet, and the lateral pigment-spots are characteristic. More advanced forms are represented in Plate XCIV, figs. 15 and 15 *a*, both having so many of the adult characters that their relationship is readily made out; the latter being procured in July, the former in October.

Disoma.—So far as known, this form, which occurs in the Cattegat and other regions, has not yet been procured in British seas, but its pelagic larva should be looked for in the tow-nets in the North Sea.

Family XXII.—Cirratulidæ, *Malmgren*.

Head distinct but small, always devoid of appendages. Buccal segment with ventral mouth; proboscis always unarmed. Two achætous segments follow. Body linear, filiform, elongated, with numerous narrow rings. Tentacles present or absent, dorsal or ventral (prehensile?). Branchiæ long, filiform, contractile, dorso-lateral in position, in many or a considerable number of segments. The corpuscles in the blood of *C. chrysoderma*, Claparède, are flattened-fusiform in shape. In this and others their colour is identical with the liquid in which they float. Feet biramous, divisions separate; without setigerous processes or appendages; superior division generally with capillary bristles, or with bristles and crotchets; inferior division with shorter bristles or with these and crotchets or crotchets alone.

In *Cirratulus tentaculatus* the body-wall has externally a thin cuticle over the hypoderm with areolæ and glandular cells internally. Beneath is the thick basement-membrane, internally a thin circular muscular layer which is continued external to the nerve-area across the mid-ventral line, the neurilemma and neuroglia intervening between it and the cords proper, around which, and especially ventrally and laterally, numerous deeply-stained cells of the neuroglia occur, the middle region below the nerves being often opaque from this cause, and on cross-section reticulations spread upward to the cords. Moreover the region between the cords and the basement-tissue of the hypoderm varies in extent, apparently from the stretching of the tissues. At the ganglionic enlargements the vertical area is considerably increased, and in some sections two small neural canals are present under the cords on each side of the middle line. The two cords are distinct in the interganglionic areas, surrounded by their investments. A median mesentery fixes the ventral blood-vessel over them, and the slender oblique muscle is attached to the upper and outer angle of the area. The dorsal arch is formed of the cuticle and hypoderm, then follows a dense layer of basement-tissue which does not

[1] 'Quart. Journ. Micr. Sc.,' vol. xxxvi, N.S., p. 71, pl. viii, figs. 4—7.

stain. Such a coat is probably of a highly elastic nature, and, with the thin circular fibres to its inner side, controls the dilatation of the body-cavity. In some species this is a muscular coat throughout. The elastic basement-layer bends inward at the sides, and ceases at the lower border of the dorsal longitudinal muscle near the lateral blood-vessel, its continuation, bounding the ventral half of the body, being considerably thinner. The dorsal longitudinal muscles are widely spread out, though in some species a median gap occurs dorsally, and with the ventral longitudinal encircle the body. The ventral longitudiual are somewhat thicker than the dorsal and pass to the nerve-area, on each side of which superiorly a blood-vessel occurs. The gut has externally a circular layer under the cœlomic epithelium, and internally a thick glandular layer of columnar cells.

In the anterior third of *Cirratulus cirratus* (Fig. 125) a continuous tough basement layer

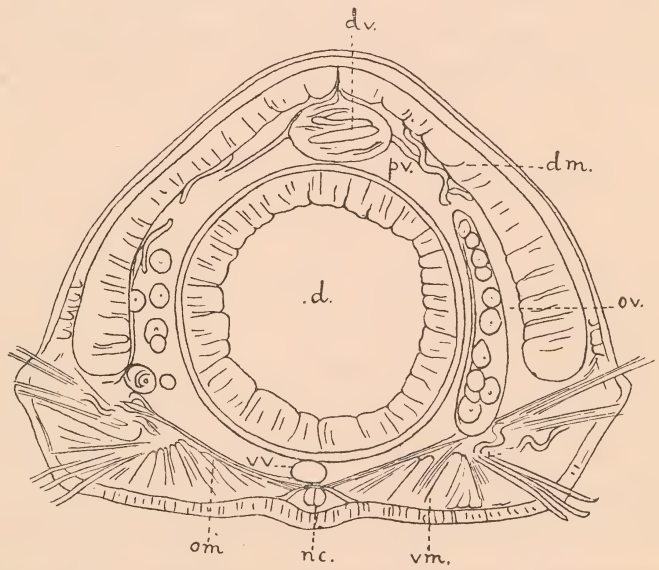

Fig. 125.—Transverse section through the anterior third of *Cirratulus cirratus*, O. F. M., from Shetland.

occurs beneath the thick glandular hypoderm with the tough cuticle, and it often separates with the hypoderm from the rest of the tissues. This elastic coat is one of the controlling tissues in dilatation, as in *C. tentaculatus*, the other being the comparatively thin circular muscular layer beneath. The longitudinal muscular coat is nearly continuous dorsally and ventrally; the dorsal, being thickest inferiorly in sections, often curve inwards over the oblique, and in the mid-dorsal line, where they are continuous, a slight increase occurs in some preparations. The ventral longitudinal are somewhat thicker and less expanded, and pass to each side of the nerve-cords. They are boldly fasciculated in transverse section. The nerve-cords lie in a hypodermic area outside the circular coat, surrounded by neurilemma, and have the circular coat internally, whilst the oblique muscles pass to the fibres over their summit. In sections of the anterior third the folded proboscis lies over the gut, and between them is the large dorsal vessel. In the anterior region certain definite large flattened pouches contain the ova, but the relation of these to dissepiments, ovisacs, gonoducts, or other structures is unknown. A section of one is represented on the right of the figure.

In *Chætozone* the structure of the body-wall generally agrees with that of *Cirratulus*,

the circular muscular coat being well developed all round. The nerve-trunks are flattened and lie in the hypoderm outside the circular coat. Both dorsal and ventral longitudinal muscles have narrow fasciculi. The large size of the dorsal blood-vessel and its deep red hue are conspicuous. A strong mesentery on each side is fixed to the ventral wall of the gut, passes to the circular coat over the nerve-cords, and ensheathes the ventral blood-vessel. The fibres of this mesentery are in various sections continuous, with similar fibres ensheathing the dorsal trunk, and passing downward in close proximity to the gut.

The branchial filaments in this group in some cases have two rows of cilia. In others again the tentacular processes have a single row.

De Blainville (1828) placed *Cirratulus* under the *Nereiscolecia*, the fourth family of the order *Homocriciens*, associating it with *Lumbrinereis*, *Cirrinereis*, and *Nainereis*—forms by no means closely allied.

Audouin and Milne Edwards (1834) arranged the Cirratulids under their "Ariciens," pointing out that Lamarck established the genus after the descriptions and figure of Strœm and Otho Fabricius, these authors considering their form allied to the Lumbricidæ. Lamarck, however, thought otherwise, and Savigny showed how it differed from that group, an opinion confirmed by Dr. Johnston, who, with Savigny and De Blainville, adopted Lamarck's title. Audouin and Edwards discriminated between the branchiæ and the cirri, but they observed no eyes. Milne Edwards (1834) divided the group into two divisions, viz. (*a*) species in which the branchial filaments were fixed to the dorsum of a segment in the anterior region of the body, *e. g. Cirrhatulus Lamarckii*, and (*b*) species devoid of filiform branchiæ fixed to the dorsum *e. g. Cirrhatulus Bellavistæ*, Blainville. Grube (1851) adopted this arrangement, the genus being placed between *Sphærodorum* and *Aricia*.

Œrsted placed the Cirratulidæ under his *Chætopoda terricolina*, the third group of his Maricolæ, and under the family Ariceæ, as a genus of the *Ariceæ lumbricinæ*. Besides the form of the body and the conical head, he describes them as having no branchiæ, or small ones in segments two to seven; in the third or eighth a transverse series of branchiæ; in the succeeding segments a pair, and bifid feet (duæ pinnæ vel fasciculi setarum capillarium).

De Quatrefages (1850) describes the nervous system of *Cirratulus fuscescens* as composed of two cephalic ganglia, two slender œsophageal connectives giving off the visceral nerves, apparently without a ganglionic enlargement, and a double ventral chain bound into a single band by what he calls a *dura mater*.

In "*Cirrhatulus Lamarckii*" Dr. T. Williams figures the segmental organ as a loop with the ends nearly approximated and placed vertically in each segment. The ova escape from the segmental organ into a dependent tissue which fills "the segment."

De Quatrefages (1865) placed the Cirratulidæ between the Neriniens (Spionidæ) and the Chloræmidæ, and considered their organisation generally approached that of the errant annelids, though in some respects they came near the sedentary forms. He found three plans on which the branchiæ were arranged, viz. first in most segments of the body except the two or three anterior and the last; in the second group these organs form transverse rows on the dorsal surface of the anterior segments; whilst in the third they are disposed in pairs in four or six of the anterior segments. He did not clearly differentiate between the cirri and the branchiæ, and he appears to have entertained the

notion that these organs, which have remarkable vitality, and which have the function of organs of prehension, locomotion, and of respiration, also under favourable conditions might reproduce the species, or perform the functions of buds. Of this, however, he had no actual proof. No corroboration of such a view has been forthcoming. This author based his genera on the arrangement of the branchiæ, which in those where they occur throughout the segments may be lateral (on the feet) or dorsal, both kinds being present in *Cirratulus*, whereas in *Audouinia* the branchiæ of the feet precede the dorsal branchiæ, and in *Cirrhinereis* they are only on the feet. In the others the branchiæ are confined to the anterior region, taking the place of tentacular cirri (*Dodecaceria*), or the tentacular cirri being a pair in *Heterocirrus* or three pairs in *Narganseta*.

The classification adopted by De Quatrefages, however, was lax, the same species being occasionally included under two genera. Moreover, he does not mention *Chætozone*.

Claparède (1868) describes various structural features in his Neapolitan forms, especially in connection with the respiratory and vascular systems, and gives the shape of the corpuscles of the blood. In his structural work on the sedentary annelids (1873) he mentions that anteriorly the superior lateral muscles in the body-wall go between two sets of bristles and he considered the dorsum to be divided into two moieties; yet in *Audouinia*, on the contrary, the number of these muscles diminishes. In certain Cirratulids the dorsal vessel is dilated and has a heart-body, which the author thought similar to chloragogenous tissue—it may be from infolding of the wall. The cerebral ganglia are large in certain forms.

Grube[1] (in 1872) gave a careful synopsis of the family, grouping the species under three genera, viz. *Cirratulus*, without tentacular cirri, *Heterocirrus* and *Acrocirrus* with these organs, and dwelling in limestone and shells. He used the arrangement and position of the branchial filaments to subdivide *Cirratulus*, the structure of the bristles being rarely taken into consideration, and then only as aciculæ or capillary bristles. Those with tentacular cirri included *Heterocirrus*, under which *Dodecaceria* would also apparently fall, and a new genus, *Acrocirrus*, characterised by the trapezoidal shape of the cephalic lobe, the insertion of the tentacular cirri, and the distinct setigerous tubercles. Moreover, Marenzeller describes the bristles as compound.

Ray Lankester[2] (1873) found that the few corpuscles and the fluid in the blood-vessels contain hæmoglobin. He also obtained Gregarinæ in the intestine.

In *Cirratulus filiformis* the segmental organs occur in most of the segments, according to Cosmovici (1880), attached to the anterior faces of the diaphragms. He quotes Keferstein as stating that these organs occur in the anterior segments following the buccal, whereas he found them in the middle and posterior regions of *C. filiformis*.

Levinsen[3] (1883) made the Cirratulidæ the third family of his *Syllidiformia Spionina*, following the Chætopteridæ and succeeded by the Ariciidæ, a classification which does not improve on that of Malmgren. He ranged the genera thus: *Dodecaceria*, *Chætozone*, *Cirratulus*.

Carus (1885) made the Cirratulida the first family of the Limivora.

[1] 'Sitzb. Schles. Gesell.,' nat. hist. sect., p. 27; *vide* also 'Arch. f. Naturges.,' Bd. xxxix, p. 458.

[2] 'Proc. Roy. Soc.,' No. 142.

[3] *Op. cit.*, p. 180.

Cunningham[1] (1888) describes three longitudinal cords as occupying nearly the whole cavity of the dorsal blood-vessel, the cords occasionally anastomosing. They have no connection with the walls. These are the heart-bodies.

De St. Joseph (1894) makes two great divisions of the family, viz. (1) Cirratulids devoid of large prehensile tentacles, and (2) those having such. In the first are (1) *Cirratulus*, in which the tentacles appear at the same time as the branchiæ; (2) *Audouinia*, in which the segments bearing the tentacles are preceded by a variable number of segments with lateral branchiæ; (3) *Cirrinereis*, which has no lateral branchiæ and no tentacular filaments. He remarks that the tentacular filaments of *Cirratulus* and *Audouinia* do not differ materially in external appearance from the lateral branchiæ, and he disagrees with Claparède's account of their structure. This, however, had been previously alluded to by Cunningham and Ramage,[2] who describe the characteristic groove of the tentacles, with the nerve-strand at the base of the ridges and the presence of a single blood-vessel, whereas in the branchiæ two blood-vessels are present, viz. one at each pole in section with an accompanying nerve-twig.

In De St. Joseph's second division are, amongst others, *Dodecaceria*, *Heterocirrus*, and *Chætozone*.

After Marenzeller, he also utilises the bristles as aids in classification. Thus in the first group only capillary bristles appear in the two setigerous papillæ, in the second group capillary bristles occur throughout in the dorsal division, whilst crotchets are present in a certain number of the ventral papillæ; and in the third group there are capillary bristles and crotchets in a certain number of both divisions.

An important memoir on the epitokous forms of the Cirratulidæ by Professors Caullery and Mesnil[3] appeared in 1898. In *Dodecaceria concharum* they found a small pelagic epitokous form and a large sedentary epitokous form, besides the ordinary type, and the masterly manner in which the authors treat the subject morphologically and physiologically is worthy of all praise. They trace the initiatory changes, the completion of the transformation externally and internally, and compare the condition with that in other Cirratulidæ. In their form A (the ordinary type) the eggs are bluish and some are developed in the cœlom of the female, and gain the exterior through the segmental organs. They also think that this form is parthenogenetic as only one male was found. In this connection it is noteworthy that *Cirratulus chrysoderma*, Claparède, is stated to be viviparous, the young occurring in the body-cavity of the parent.[4] In the young there are eyes, but they by-and-by disappear. The adult has fifty segments, and cysts of Distomes were found in it. In form C the ova, which are developed in autumn, are the smallest of the three (130μ, and in the pelagic form 90μ) and of a brownish yellow colour. They find exit by the segmental ducts, which open in the middle of mucous glands. Of this series only females were met with and they may be parthenogenetic. The colour is pale coffee, and the stout crotchets are similar to those of A, only they have no spike at the base of the terminal excavation. The development of the mucous glands is a prominent feature. It is probable that C

[1] 'Quart. Journ. Micr. Sc.,' vol. xxviii, N.S., p. 265, pl. xviii, fig. 21.

[2] 'Trans. Roy. Soc. Edinb.,' vol. xxxiii, p. 644, 1888.

[3] 'Annales l'Université Lyon,' Fasc. xxxix, pp. 1—192, pls. i—vi.

[4] 'Zeitschr. f. wiss. Zool.,' Bd. xix, p. 192.

deposits eggs, more or less agglomerated in its tubes, in the interior of *Lithothamnion*. The wall of the digestive tube is atrophied, but to a less extent than in A, and the animal takes food.

In their form B, which is ripe in August, the males and females occur in equal numbers, and the large yellowish eggs (200μ), are shed externally and fertilised in the water. This form gradually undergoes a change into the epitokous condition, with two large eyes, long bristles, and a more translucent body, the stout, spoon-like crotchets disappear, and there is atrophy of the palps. In the early stage of B only the anterior pair of nephridia are conspicuous, for the authors did not recognise them in the posterior region. Then ensues a series of internal changes, the increase in the size of the eyes, the atrophy of the palps, the shrinking of the branchiæ, and the atrophy of the alimentary canal. The animal consumes the reserves accumulated in the eosinophile granulations of the cœlomic cells, and develops nephridia in the posterior segments. A gregarine (*Gonospora longissima*) occurs in the cœlom.

Caullery and Mesnil consider *Heterocirrus ater*, De Quatrefages, as identical with *Dodecaceria concharum*, and so with *H. saxicola*, Grube, *H. fimbriatus*, Verrill, and *Terebella ostreæ*, Dalyell. In the case of *Heterocirrus viridis* it is otherwise.

Michel (1898) has observed small buds in this genus posteriorly.

Picton[1] (1879) is of opinion that the brown granules of the heart-body in the Cirratulidæ are neither chitin nor guanin, thus differing from the Chloragogens described by Schæppi in *Ophelia*; that the ovoid crumpled bodies are chitinous, that fat is present, that iron occurs in the granules, and that glycogen is absent.

Anna Dyrssen[2] (1912) studied *Cirratulus cirratus*, *Audouinia filigera*, and *Amphitrite rubra*, and considers that the heart is mesodermic, and that the hæmocytes are immigrant cœlomocytes; that the vessels, like the visceral blood-sinus, have an internal connective-tissue membrane; that there is no vaso-epithelium; that the walls of the vessels are mesodermic. But embryological evidence is needed for confirmation.

Ripe specimens of *Cirratulus* occur in May, and a young example, 3 mm., was captured in September.

Cirratulids generally frequent sandy mud, often of a putrid nature, though some, as *Dodecaceria* and *Heterocirrus*, bore in calcareous substances. *Chætozone*, again, is found at great depths, *e. g.* 1250 fathoms in the 'Challenger.' Though some have no proper tube they are truly sedentary forms.

Genus CVI.—Cirratulus, *Lamarck*.

Lumbricus, O. F. Müller.

1. Cirratulus tentaculatus, *Montagu*, 1808. Plate XCI, fig. 1; Plate XCII, fig. 1—tail, from life; Plate XCVIII, fig. 18—tail; Plate CVII, figs. 1 and 1 *a*—bristle and hook.

Specific Characters.—Head conical, on each side a short distance from the tip an oblique depression sloping outward and backward, and from the union of the converging

[1] 'Quart. Journ. Micr. Sc.,' vol. xli, n.s., p. 271, pls. 19 and 20.

[2] 'Jen. Zeitschr. Naturw.,' 4B (1912), pp. 365—397, 4 pls. and 5 figs.

grooves a ridge passes to the tip of the snout. Ventrally a deep groove leads backward to the mouth, which has posteriorly a thick transverse lip. Occasionally a band of ocular points crosses the posterior border of the prostomium. Body six to nine inches in length, rounded dorsally, flattened ventrally, tapered anteriorly, and more distinctly but gradually diminished posteriorly, the terminal anus having a small projecting process below it. Colour of a dull yellowish-orange in front, and dull yellow elsewhere, enlivened by the red blood-vessels. Some show vertical lines of dark pigment in the sulci at the segment-junctions from the fourth segment backward for some distance. Foot has dorsal and ventral setigerous processes; the former bearing capillary bristles to the ninety-second or thereabout when crotchets appear; crotchets, on the other hand, occurring about the sixty-second ventral division. Capillary bristles have stout shafts and long, flattened, tapering tips with a narrow web of spines directed distally. Crotchets with strong shafts, the neck curving backward and then forward at the tip. Branchiæ commence on the dorsum of the first foot, and the tufts of tentacles are on crescentic areas on the dorsum, between the fifth and sixth bristled segments (seventh body-segment, Carus). The branchiæ occur singly along each side of the entire anterior region, and are absent from the last thirty or forty.

Synonyms.

1808. *Terebella tentaculata,* Montagu. Trans. Linn. Soc., vol. ix, p. 110, pl. vi, fig. 2.
1812. „ „ Pennant. Brit. Zool., ed. 4, vol. iv, p. 111.
1817. *Cirratulus Lamarckii,* Cuvier. Règne Anim., t. iii, p. 205.
1828. *Cirrinereis filigera,* De Blainville. Dict. Sc. nat., t. lvii, p. 488.
„ *Lumbricus filigerus,* Delle Chiaje. Memorie, vol. iii, p. 171, Tav. xliv, fig. 1.
1833. *Cirratulus Lamarckii,* Audouin and Edwards. Ann. Sc. nat., t. xxix, p. 410, pl. xv, figs. 1—4.
1834. „ „ idem. Hist. nat. Litt. France, t. ii, Annél., p. 271, pl. vii, figs. 1—4.
1836. *Cirrhatulua tentaculata,* Templeton. Loudon's Mag. Nat. Hist., vol. ix, p. 234.
1838. *Cirratulus Lamarckii,* Grube. Anat. u. Physiol. Kiemenw., p. 32.
„ *Cirrhatulus tentaculatus,* Fleming. Mag. Zool. and Bot., vol. ii, p. 73.
1840. *Cirratulus Lamarckii,* Grube. Actin. Echin. u. Würm., p. 70.
1841. „ „ Delle Chiaje. Descriz., vol. iii, p. 85.
„ „ *filigerus,* idem. Ibid., p. 85.
1847. „ *Lamarckii,* Cuvier. Règne Anim., Disciples' ed., Annél., p. 39, pl. xvii, fig. 3.
1851. „ „ Grube. Fam. Annel., pp. 67 and 134.
„ „ „ Williams. Rep. Brit. Assoc. for 1850, pp. 200, 216, and 236.
1864. „ „ Grube. Insel. Lussin, p. 85.
1865. „ *tentaculatus,* Johnston. Cat. Worms Brit. Mus., pp. 209 and 243.
„ *Audouinia Lamarckii,* De Quatrefages. Annel., t. 1, p. 460.
„ „ *crassa,* idem. Ibid., p. 461.
1869. *Cirratulus Lamarckii,* Grube. Mitth. St. Vaast, Abh. Schles. Ges., 1869, p. 37.
1875. „ „ Panceri. Atti Soc. Ital., vol. xviii, p. 526.
„ *Audouinia filigera,* idem. Ibid.
1879. *Cirratulatus tentaculatus,* Tauber. Annul. Danica, p. 120.
1881. *Audouinia filigera,* Langerhans. Canarisch. Annel., p. 115.
1883. *Cirratulus tentaculatus,* Levinsen. Vidensk. Meddel. Nat. For., p. 111.
1885. „ *Lamarckii,* Carus. Fauna Medit., p. 247.

1888. *Cirratulus tentaculatus,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 646, pls. xxxviii, and xxxix, fig. 10.
„ „ „ Marenzeller. Polych. Angra Peq. Bucht., Zool. Jahrb., Bd. iii, p. 18.
1891. „ „ Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 253.
1893. *Audouinia filigera,* Lo Bianco. Atti Accad Sc. Napoli, 2d ser., vol. v, p. 4.
1894. „ *tentaculata,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 48, pl. iii, figs. 55—57.
1898. *Cirratulus tentaculatus,* Michaelsen. Polych. deutsch. Meere, p. 144.
1901. *Audouinia filigera,* Ehlers. Polych. Magell. u. Chil., p. 183.
1904. „ *tentaculata,* Journ. M. B. A., vol. vii, p. 228.
1907. „ *filigera,* Fauvel. Bull. Inst. Ocean., No. 107, p. 17.
1909. „ „ Lo Bianco. Mitt. Zool. St. Neapel, Bd. xix, p. 577.
1910. *Cirratulus tentaculata,* Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 237.
„ *Audouinia* „ Elwes. Journ. M. B. A., vol. ix, p. 63.
1911. *Cirratulus tentaculatus,* McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 151.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 107.

Habitat.—Abundant under stones on muddy and sandy ground between tide-marks, or in blackish odoriferous muddy sand all round the shores of Britain from Shetland to the Channel Islands, and from the Forth to Valencia. Such muddy sand, indeed, is often quite furrowed by them, and their trailing vermiform tentacles stretch as deep orange threads in all directions. They also frequent the chinks of aluminous shale and other rocks, and the empty holes of *Pholas crispata*, from which they are dragged with difficulty. Young specimens occur in tubes on the sandstone rocks, coast of Devonshire (Montagu); Plymouth; Malahide, Co. Dublin (R. I. A.); Stennick's Island, Skerries, Blacksod Bay, and other western shores (Southern); Torquay (Elwes); Dublin; Baltimore Bay, Co. Cork, along with *Nereis cultrifera* (Father Davies).

Abroad it is recorded from the shores of France (Audouin & Edwards, De Quatrefages, De St. Joseph), Madeira and Canaries (Langerhans, Fauvel), Mediterranean (Panceri, etc.).

Head (Plate XCI, fig. 1) conical, with, on each side, a short distance from the tip, an oblique depression sloping outward and backward, and from the point at which these converging grooves meet a ridge runs forward to the tip of the snout. Ventrally a deep sulcus leads backward to the mouth, which is bounded posteriorly by a thick transverse lip. In some from Lochmaddy a little pigment occurs on the snout at the posterior and outer angle of the triangular anterior region, thus simulating eyes; indeed, the pigment is occasionally symmetrically arranged. In others from Guernsey and Herm a distinct band of ocular points passes from one side of the base of the prostomium to the other, just in front of the constriction indicating the region. A variety with a blackish snout is met with in Herm, and Dr. Sorby sent some in a similar condition from the estuary of the Orwell near Ipswich.

Body 6—9 inches in length, rounded on the dorsum, flattened ventrally, tapered anteriorly and more distinctly but gradually diminished posteriorly, where it ends in a pointed tail, the slit-like anus being dorsal, whilst on the ventral median line is a small process like a rudimentary cirrus (Plate XCII, fig. 1, and Plate XCVIII, fig. 18), and some show in lateral view a process above and a little in front of the ventral papilla, the anus being between. Others, again, have a large terminal anus with a rim and no

process. Such, perhaps, may be connected with injuries and reproduction. The number of segments is 300 or upward in a large example.

Colour of a dull yellowish-orange in front, and dull yellow behind, the long tentacles being orange, whilst the blood-vessels give streaks of red to the various parts. Some show vertical lines of dark pigment in the sulci at the segment-junctions from the fourth segment backward for some distance.

On an elevated ridge which lies dorsally between the fifth and sixth bristled segments is a dense mass of tentacles on each side. In shape the elevation is somewhat crescentic in front, straight behind, and the cluster of tentacles numbers at least twenty.

Each segment behind the foregoing has laterally its branchia situated behind and rather above the level of the upper bristle-tuft, and this throughout the whole anterior region—to the number of about 100—at least in large examples. The branchiæ are more scattered in the middle and posterior regions, and cease altogether about the thirty-fifth or fortieth from the tip of the tail. After the seventh or eighth the bristled segments are very narrow for a considerable distance, then become slightly wider, and again toward the tip of the tail are very narrow (Plate XCII, fig. 1, and Plate XCVIII, fig. 18).

The remarkable spiral coils of these organs constitute a feature of the species. They have no cilia, and contact with pure sea-water is less congenial to the animal than mud, which at least enables it to separate the long, coiled structures. Claparède mentions the occurrence of cilia on these organs in *C. chrysoderma*.

The peristomial segment is somewhat narrower than the two which follow, each of which has various transverse creases or wrinkles. These three are devoid of bristles, hooks, or other appendages.

The first setigerous segment succeeds the foregoing, and is broader than its successors. The foot is represented in the lateral region only by dorsal and ventral setigerous processes, which bear tufts of capillary bristles; moreover, near the junction with the segment behind, and almost on a level with the upper bristles, is a long coiled branchia. The capillary bristles (Plate CVII, fig. 1) have somewhat stout shafts and long, flattened, tapering tips with a narrow web of spines directed distally. The figure given by De St. Joseph (‘Ann. Sci. nat.,’ 8e sér., xvii, pl. iii, fig. 53) is only diagrammatic. These bristles have a uniform translucent aspect, and the flattening is evident when twisted. They are slightly tapered toward the base, whilst the tips are very delicate. Faint transverse wrinkles occur at the base and for a short distance above it.

The four or five bristled segments which succeed are broader than those next them, but all have the capillary bristles dorsally and ventrally. In the groove between the second and third bristled segment a second and smaller branchia occurs, the base arising a little above the level of the dorsal bristle-tuft, and so with the following segments, viz. in the groove between the third and as far as the sixth.

The branchiæ and tentacles vary in size according to the degree of development, those in process of reproduction being often very small, whilst the older examples are thick. All are minutely ringed, probably from the muscular fibres.

The strong hooks (Plate CVII, fig. 1 *a*) commence in the large examples from Plymouth in the ventral series at the sixty-second bristled segment (sixtieth to sixty-fifth in others). They are at first slender, but soon become robust. The

neck curves backward, then forward at the tip, and probably is the main agent in giving the animal a firm hold of its burrow. Their appearance in the dorsal division is somewhat late, viz. between the ninety-first and ninety-fifth. In both cases the foregoing figures differ from those of Marenzeller and De St. Joseph. Marenzeller states that the first ventral hooks appear in *C. tentaculatus* between the thirty-third and forty-fifth segments, and the dorsal between the fortieth and sixty-fourth, whereas in *Cirratulus Chiajii* the ventral appear between the twenty-first and twenty-third, and the dorsal between the fortieth and forty-fourth. The great variation in the appearance of these structures in British examples of *C. tentaculatus* would also, as De St. Joseph observes, lead to some doubt as to specific identity based on this feature.

An examination of two examples of *Cirratulus* (*Audouinia*) *filigerus* from Naples shows that in one the anterior tentacles arise less definitely than in *C. tentaculatus*, it being difficult to say whether they are mainly opposite the sixth or the seventh bristles, whereas in the other they are more like those in *C. tentaculatus* in regard to transverse arrangement, and they arise opposite the fifth pair of bristles. In both a branchia springs in front of the dorsal of the first series of bristles. The first ventral hooks occur on the thirtieth bristled segment on the right in the first referred to, and the first dorsal hooks on the forty-first; whereas in the other example, with the groups of tentacles opposite the fifth bristles, the first ventral hook occurs on the nineteenth bristled segment, and the first dorsal hook on the thirty-seventh. These hooks are slightly less curved toward the tip than those of the northern form, but otherwise are similar. The bristles are proportionately longer than in *C. tentaculatus*.

Fragments from the middle of the body appear to be able to reproduce a head and tail, the broad ruptured ends contracting and the respective parts gradually developing. When about an inch of the tail of a large form is broken off a cephalic process buds out from the dorsum of the anterior end, and the alimentary aperture is contracted.

Habits.—When several are placed in a vessel of sea-water they immediately roll themselves together, entangling mud and other animals present—forming a mass difficult to unravel. In their native sites the long threads stretch themselves in every direction in the mud, which seems to be the most fitting medium, since it keeps the filaments apart; whereas in pure sea-water the animals appear to be less comfortable. They also occur in the fissures of aluminous shale between the tide-marks. Like *C. cirratus* it frequently enters empty tubes of other forms. Thus two small examples so fixed themselves in the tube of a *Serpula* that even after immersion in spirit the wall of the tube had to be broken before they could be removed.

This annelid would seem to be less eagerly devoured by fishes than the majority. When placed in a tank with *Cotti* and flounders, the former seized it as it descended from the surface, and, after a few seconds, ejected it, whilst the flounders only gazed at it.

Reproduction.—In the middle of May examples at St. Andrews were loaded with dark greyish ova, 0·1143 mm. in diameter. Males toward the end of June discharged from the posterior region of the body a vast cloud of minute sperms with globular heads and a slender posterior process or "tail." The heads are much more minute than those of *Enlalia viridis*. At Naples Lo Bianco (1909) gives the period of sexual maturity as from June to

November. Elwes (1910) observes that the young, 40 mm. long, appear to live in crevices in rocks.

Claparède and Mecznikow[1] describe a young Cirratulid, it may be pertaining to *C. chrysoderma*. It was obtained in May, and had about six segments, a pair of eyes on its conical snout, a mouth, pharynx and intestine, lateral cirri, a dorsal and two lateral blood-vessels. In the body-cavity were two enigmatical bodies which the authors thought might be ova of a parasitic crustacean.

Montagu (1808) found his example in a piece of timber perforated by boring molluscs, and it was 8 or 9 inches in length.

Claparède distinguishes (in *C. chrysoderma*) between tentacles and branchiæ in such forms by the fact that the former (tentacles) have only one blood-vessel, whilst the latter have two.[2] The single vessel in the tentacle terminates in a blind extremity; moreover, the walls of the tentacles are thick with rhythmical contractions which drive the blood to and fro in the single vessel. In *Audouinia filigera*, on the contrary, every filament is branchial in structure.

The segmental organs in this species occur in the second segment, and in *Audouinia filigera* they are met with in the first. The blood is charged with fusiform flattened corpuscles, which Claparède says do not enter the lateral branchiæ.

Cunningham and Ramage (1888) describe the lateral branchial filaments as arising immediately above the base of the dorsal division of the foot.

Brasil[3] (1904) describes the occurrence of a sporozoon, *Angeiocystis Audouiniæ*, in the cardiac body of this form, and he followed it through the various phases of macrogametes, microgametocytes, microgametes, ookysts, sporozoites, and schizonts.

Gravier[4] (1906) retains the main characters of the family as given by Grube, De Quatrefages, and others, and also conserves the genus *Audouinia* of De Quatrefages for a new species from the Red Sea.

2. Cirratulus Chiajii. Plate XCIV, fig. 18—foot; Plate CVII, fig. 3—hook.

Specific Characters.—Head a short cone. Body 2—3 inches long, more slender and delicate than in *C. tentaculatus*, but of similar shape, the anus being dorsal with a short cone beneath. Immediately behind and rather above the first bristled foot is a branchia, and so with the three following. On the dorsal line between the fourth and fifth bristle-tufts is a group of four or five slender branchiæ. The branchiæ occur singly on each side behind the foregoing, and are sparsely distributed along the posterior region almost to the tail. The crotchets appear in the ventral division about the twentieth foot, whilst they occur in the dorsal division about the fortieth foot. The crotchets have their curves somewhat more pronounced than in *C. tentaculatus*, and posteriorly the ventral are considerably larger and stronger than the dorsal.

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xix, p. 192, Taf. xiv, fig. 4, 1868.

[2] Williams was thus correct in regard to the double vessel in "*C. Lamarckii.*"

[3] 'Compt. Rend. Acad. Sci.,' Paris, t. 139, p. 645.

[4] 'Nouvelles Arch. Mus.,' 4e sér., t. viii, p. 150.

Synonyms.

1828. *Lumbricus filigerus,* Delle Chiaje. Mem., iii, p. 178, tav. xlv.
1840. *Cirratulus Lamarckii,* Grube. Actin. Echin. u. Würm., p. 70.
1841. „ *filigerus,* Delle Chiaje. Descrizione, iii, p. 85; v, p. 99, tav. xci, figs. 1—2, tav. lxxx, fig. 1.
1868. *Audouinia filigera,* Claparède. Annél. Nap., p. 267, pl. xxiii, fig. 3.
1885. „ „ Carus. Fauna Medit., p. 247.
1900. „ „ Ehlers. Schwed. Magellan. Annel., p. 14.
1901. „ „ idem. Annel. Sammlung Plate, p. 265.
1911. „ „ Fauvel. Arch. Zool. expér., vol. xlvi, p. 410.
„ „ *filigerus,* McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 154.
1914. ? *Cirratulus norvegicus,* Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 107, pl. xi, figs. 26, *a–d.*

Habitat.—Malahide, Co. Dublin, Roy. Irish Acad.; various parts of the Irish coast (Southern).

If this is the *Audouinia filigera* of Claparède and Delle Chiaje it occurs at Algiers (Marion); Marseilles (Marion and Bobretzky); Naples (Delle Chiaje and Claparède); Gulf of Persia (Fauvel); Magellan (Ehlers).

The *head* forms a short cone, the mouth opening on the buccal segment a little behind.

The *body* is more slender and delicate than in *C. tentaculatus*, proportionally more elongate, and but slightly tapered anteriorly and posteriorly, the anus being dorsal with a short terminal cone beneath it. The first three segments, that is, the buccal and two following, are achætous, and the first bristled segment is hardly wider than that in front. It bears a dorsal and a ventral tuft of capillary bristles of moderate length, and the succeeding seventeen or eighteen are similar in this respect. At the twentieth foot the dorsal division has three slender, curved crotchets, and about the same number of somewhat flattened capillary bristles, with finely tapered tips, and alternating with the crotchets; ventrally are three much stronger curved crotchets with a few short and slender capillary bristles, the proportions of these being seen in the sketch (Plate XCIV, fig. 18).

Immediately behind and rather above the first bristle-tuft is a branchia, and so with the three following feet. On the dorsum in the line between the fourth and fifth bristle-tufts is a group of slender branchiæ, apparently four or five on each side. In the preparation they are shorter than those which follow in single series on each side along the dorsum, and they occur sparsely distributed along the posterior region till near the tail.

This form differs from *C. tentaculatus* in so far as the crotchets appear in the ventral division about the twentieth bristled foot, and in the dorsal division shortly after the fortieth. The hooks (Plate CVII, fig. 3) have their curves somewhat more pronounced than in *C. tentaculatus*, and posteriorly the ventral are larger and stronger than the dorsal. Both are accompanied by a few capillary bristles.

This may be the *Audouinia filigera* of Claparède. He describes a single pair of segmental organs in the first setigerous segment, their apertures on the ventral surface being marked by pigment.

Carus (1885) observes that it resembles *Audouinia Lamarckii*, of which it may be a variety, but that the tentacular filaments occur on the fifth, not on the seventh, body-segment.

3. Cirratulus cirratus, *O. F. Müller*, 1776. Plate XCI, fig. 2; Plate CVII, figs. 2–2 *c*—bristles and hooks.

Specific Characters.—Head broader than in *C. tentaculatus*, hoof-shaped, but with a slight central notch, and two well-marked bands of eyes sloping obliquely outward and backward. It and the succeeding segment are devoid of appendages and double the breadth of those which follow. Body 3 to 6 inches in length, and having 106 to 130 segments, which are more distinct than in *C. tentaculatus*. It is generally smaller than the latter, rounded dorsally, and flattened ventrally, where a deep median groove occurs. Vent terminal with a crenate border. Colour yellowish-orange to deep madder brown. Cirri yellow and red throughout. Branchiæ commence on the first bristled segment (fourth) in the form of two lateral dorsal tufts with seven or eight in each. Feet more prominent than in *C. tentaculatus*, and the divisions are closer. The first twelve bear capillary bristles only, the ventral shorter than the dorsal. A crotchet appears in the ventral of the thirteenth foot, and in the dorsal at the thirtieth foot. The shaft of the crotchet dilates a little from the base upward above the middle, where there is a slight forward curve, then a slight bend backward takes place, and again a forward curve to form the terminal hook.

Synonyms.

1762. *Lumbricus marinus cirris longissimis, s. cirrosus.* H. Ström. Physik. œcon. Beskriv. over Fogder. i Bergens, Stift. 1 Sorve., p. 188.
1768. „ „ Parelius. Norske Bid. Selsk. Skrift., iv, p. 428, Tab. xiv, fig. 7.
1770. „ *marinus cirris longissimis,* Ström. Skrift. Kjöbenh. Selskab., x Deel, p. 26, Tab. viii.
1774–93. „ „ „ „ Martini. Naturlex, ii, p. 482, taf. E, fig. 6.
1776. „ *cirratus,* O. F. Müller. Zool. Dan. Prodr., n. 2608, p. 214.
1780. „ „ Fabricius. Fauna Grönl., p. 281, no. 226, fig. 5.
1791. „ „ Gmelin. Linn. Syst. Nat., ed. 13, i, p. 3086.
1800. „ *marinus cirris longissimus,* O. F. Müller. Wurm-Arten, p. 193.
1825. *Cirratulus fuscescens* and *C. flavescens,* Johnston. Edinb. Philos. Journ., vol. xiii, p. 219.
1828. *Cirrhatulus borealis,* De Blainville. Dict. Sc. nat., t. lvii, p. 490.
„ *Cirratulus* „ Stark. Elements, ii, p. 141.
1833. „ *medusæ,* Johnston. Mag. Nat. Hist., vol. vi, p. 124, fig. 13.
1838. „ „ idem. Mag. Zool. and Bot., vol. ii, p. 71, pl. iii, figs. 7—12.
1840. „ *borealis,* Lamarck. Anim. s. Vert., t. v, p. 302; 2nd edit., t. v, p. 536.
1842. „ „ Œrsted. Kroyer's Naturh. Tidsskr., Bd. iv, p. 126.
1843. „ „ Rathke. Nova Acta Acad. Leop.-Car., xx, p. 180, Tab. 8, figs. 16 and 17.
„ „ „ Œrsted. Annul. Danic. Consp., p. 43.
„ „ „ idem. Grönl. Annul. Dorsib., p. 206, figs. 98 and 102.
1844. „ „ idem. Reg. Mar., p. 78.
„ „ „ idem. Arch. f. Naturges., Bd. x, p. 109.
„ „ *Medusa,* W. Thompson. Ann. Nat. Hist., vol. xiii, p. 437.
1849. „ *borealis,* Leuckart. Arch. f. Naturges., Bd. xv, p. 196, pl. iii, fig. 10.
1851. „ „ Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 207.
„ „ „ Grube. Fam. Annel., pp. 67 and 134.
1853. *Lumbricus cirratus,* Dalyell. Pow. Creat., vol. ii, p. 133, pl. xviii, figs. 1—4.

1857. *Cirratulus cirratus*, Koren. Nyt Mag. f. Naturvid., Bd. xi, p. 94.
1858. „ *borealis*, Grube. Mém. Sav. étrang. St. Pétersb., t. viii, p. 15 (sep. abdr.).
1861. „ „ Danielssen. Reise 1857, Nyt Mag. f. Naturvid., xi, p. 52.
1862. „ „ Keferstein. Zeitschr. f. wiss. Zool., Bd. xii, p. 120, Tab. x, figs. 19—22.
1865. „ „ Johnston. Cat. Worms Brit. Mus., pp. 210 and 343, text-fig. xxxvii.
„ „ *Medusæ*, De Quatrefages. Annel., i, p. 455.
1867. „ *cirratus*, Malmgren. Annul. Polychæt., p. 95.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 127.
1878. „ „ idem. Trans. Linn. Soc., ser. 2, Zool., vol. i, p. 507.
1879. „ „ Tauber. Annul. Danica, p. 119.
„ „ „ Théel. Kongl. svenska Vet. Akad. Handl., Bd. xvi, p. 54.
1881. „ „ Langerhans. Canarisch. Annel., p. 115.
1883. „ „ Levinsen. Vidensk. Meddel. Nat. Foren., p. 111.
„ „ „ Wirén. Chætop. 'Vega' Exped., p. 410.
1886. „ „ and *borealis*, Harvey Gibson. First Rep. Fauna, Liverp. Bay, p. 156.
1888. „ „ Cunningham. Quart. Journ. Micr. Sc., vol. xxviii, N.S., p. 224, pl. xviii, fig. 6.
„ „ „ idem and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 643, pl. xxxix, fig. 9.
1890. „ *borealis*, Malaquin. Annél. Boulonn., p. 46.
1891. „ *cirratus*, Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 253.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 98.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 144.
1898. „ „ idem. Grönland. Annel., p. 128.
1904. „ „ McIntosh. Mar. Invert. S. Africa, vol. iii, p. 67.
1907. „ „ Fauvel. Bull. Inst. Ocean., No. 107, p. 18.
1909. „ „ Percy Moore. Proc. U. S. Nat. Mus., vol. xxxvii, p. 139.
1910. „ „ Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 236,
1911. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 154.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 110.

Habitat.—Generally distributed around the shores of Britain, between tide-marks in muddy cracks and fissures of rocks and in mud under stones. It is also procured by the dredge in deeper water. At Lochmaddy it seems to be less plentiful toward low-water mark than amongst muddy sand at half-tide mark. Dublin Bay, and W. coast of Ireland (Southern); Salthill (R. I. A.); Plymouth (Spence Bate and Brooking Rowe).

Elsewhere it extends to Greenland (Œrsted), Scandinavia, Finmark, Spitzbergen (Malmgren, Théel and Fauvel); Atlantic Coast, U.S.A. (Verrill); Siberian and Behring Seas (Grube, Wirén).

Head (prostomium, Plate XCI, fig. 2) broader than that of *C. tentaculatus*, hoof-shaped, but with a slight notch in the centre, and with two well-marked bands of eyes sloping obliquely outward and backward, as also do those of *Archidice glandularis* of Langerhans,[1] from Madeira. The peristomium has inferiorly the puckered opening of the mouth.

Body three to six inches in length, narrow, elongated, with more distinct segments (which are 106 or more) than in *C. tentaculatus*, for their antero-posterior diameter is

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xl, p. 259, Taf. xv, fig. 18, 1884.

greater. It is rounded dorsally, and somewhat flattened ventrally where a deep groove runs from the first bristled segment backward to the tail. The body is slightly tapered anteriorly, and more distinctly posteriorly where it ends in a point ventrally with the anus above it, but in others the open vent posteriorly is simply crenate, probably from dilatation.

The colour varies from yellowish-orange to deep madder brown. Thus some are pink or red in front, dull yellow mottled with brown or purple from the vessels along the body, and dull yellow posteriorly. Others are deep madder brown throughout, relieved only by the lighter cirri and the iridescent wrinkles of the surface. The tail is somewhat pale. The cirri are not involved in this variation, being of the same yellow and red throughout.

Two achætous segments follow the prostomium. The fourth segment has a smaller sessile foot than the succeeding, bearing two minute tufts of bristles, which have the structure of those of the previous species. It also carries a series of proportionally large filiform branchial cirri arranged in two lateral tufts, each containing seven or eight cirri, and of an orange colour, with red blood-vessels. These coil and twist during the progress of the animal, and in proportion to the diameter of the body have a larger bulk than those of *C. tentaculatus*.

The following thirteen or fourteen segments bear branchial cirri, each arising above and slightly behind a line through the middle of the bristle-tuft. Some of these show a greater amount of blood than those in the dense anterior tufts. Here and there along the body a single cirrus springs from the dorsal arch considerably above the bristles, but the posterior region is devoid of them. On the whole the cirri are much fewer than in *C. tentaculatus*, and do not show so conspicuously the remarkable spiral coils so characteristic of that species.

The feet differ from those of *C. tentaculatus*, in so far as they are more prominent, and the superior and inferior divisions considerably closer, indeed in some, *e. g.* the first, the bases inserted in the tissues closely approach. The first twelve bristled segments have only the simple flattened, tapering bristles, the points being extremely slender (Plate CVII, figs. 2 and 2 *a*). The ventral tufts are distinguished from the dorsal by their shortness and in some by their proportionally broader tips. The dorsal bristles slightly dilate from the base nearly to the middle of the shaft, then taper gradually to the very fine hair-like tip. Parasitic structures, such as algæ, abound on them, and frequently they render them pinnate besides winding round them. The edge of each bristle is minutely and regularly spinous, the direction being distal.

At the thirteenth foot a single crotchet appears in the ventral division. These hooks (Plate CVII, figs. 2 *b* and 2 *c*) dilate a little from the base upward to rather above the middle, where there is a slight forward curve, then a faint slope backward occurs, and again a forward bend to form the hook at the tip. This projects through a neatly rounded aperture of the cuticle, is moderately acute in the uninjured forms, and in some even more curved at the tip than in the figure. In the sixteenth bristled foot three hooks are present and four in the twentieth. A bristle or two accompany the hooks.

The crotchets commence in the dorsal division about the thirtieth foot, a slender, sharp-pointed one appearing in the twenty-ninth and perhaps earlier along with the bristles. They continue to the posterior end, both divisions having a few slender tapering

bristles, which are more conspicuous than in front. So far as observed the hooks of the dorsal division posteriorly are slightly more slender and less curved than those in the ventral.

Reproduction.—Those from Guernsey and Herm in July and August had well-developed ova.

Reproduction of lost parts is common in this species, both head and tail being readily regenerated. An example from the Channel Islands has a small, pale, and somewhat triangular snout, without trace of eyes; and the tentacles arise from a pigmented area, separated only by a narrow pale space, which probably represents the two achætous segments. The mouth at this stage was an irregular puckered aperture.

A minute crustacean parasite occurred on the dorsum of an example from Guernsey, attached by the pointed anterior region, and with the swollen posterior part projecting from the surface. Unfortunately in its transit to Dr. Thomas Scott it was lost.

The *Terebella meleseta* of Montagu refers to this species.

There is nothing specifically characteristic in the figure of Dalyell (1853), though it has been included in the present species. He probably did not discriminate it from *C. tentaculatus*. He mentions that it is nocturnal, and deposited ova in May or June.

The *Cirratulus fragilis* of Leidy[1] (1855) may be this species or a closely allied form.

Cunningham and Ramage (1888) found this species depositing the reproductive elements at the end of March, the ova and sperms escaping from the apertures of the segmental organs throughout nearly the whole length of the body. The females were considerably larger than the males, viz. 9 cm. to 5·5 cm. They structurally differentiate the tentacular and the branchial cirri, the former having a single vessel, the latter two. They also allude to the heart-body, though this name is not applied to it.[2] Keferstein, Claparède, Cosmovici, and Cunningham have described the segmental organs of the group. In this species Cunningham found both a large anterior pair of organs and a series in the middle and posterior regions. The nephrostome of the first opens into the cavity of the buccal segment, and externally beneath the ventral division of the second segment. The posterior organs are smaller and simpler, appearing at the twelfth segment, and continuing to the posterior end.

Cirratulus, fragment, Lochmaddy, North Uist.

An injured fragment of a large *Cirratulus* was procured between tide-marks at Lochmaddy in August, 1865. As no crotchets are present in the region, apparently the posterior, it may belong to the first series of De St. Joseph without such organs, and including *C. chrysoderma* of Claparède. There are about eighty bristled segments in the fragment. The pale yellow bristles are slightly longer dorsally than ventrally, and are slender tapering capillary forms with hair-like tips; the branchiæ appear to go backward almost to the tip of the tail, if such is diagnosed correctly.

[1] 'Invert. Fauna Rhode Isl.,' etc., p. 147, pl. xi, figs. 39—43.

[2] They describe the "corduns bruns" of Claparède as in the interior of the dorsal blood-vessel, but not continuous with its wall. In structure these cords are glandular, having elongated granular cells placed perpendicularly to the interior of the cord, which is enclosed by a very thin basement-membrane. These cords end anteriorly at a point where the lateral vessels from which the afferent trunks to the branchiæ are given off ('Trans. Roy. Soc. Edinb.,' vol. xxxiii, p. 643).

4. Cirratulus bioculatus, McIntosh, 1911. Plate CIII, fig. 16—dorsal bristles; Plate CV, fig. 19—ventral bristles.

Synonym.

1911. *Cirratulus cirratus,* young, McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 156.

A small (young ?) form dredged in Shetland in 1867 by Dr. George Jeffreys presents the peculiarity of having only two eyes; and the head shows less of a basal constriction than usual in examples of *C. cirratus* of the same size. The complete tentacles from the fourth segment are of very great length, probably reaching in life beyond the tip of the tail which has a similar termination to that of *C. cirratus*, the ventral papilla being the more prominent.

The tenth foot has dorsally a long slender tuft of finely tapered bristles (Plate CIII, fig. 16), whilst the ventral bristles are much shorter, the flattened tips being expanded like a "bellied" knife and then tapered to a fine point (Plate CV, fig. 19). The hooks by-and-by appear in both ventral and dorsal divisions and their shape corresponds with that of the ordinary examples in *C. cirratus.*

5. Cirratulus caudatus, *Levinsen*, 1893. Plate C, fig. 13—bristles, twentieth foot; Plate CIX, figs. 14 and 14 *a*—bristles and hook; Plate CXI, fig. 3—head and anterior region.

Specific Characters.—Snout forming a blunt cone, with slight lateral furrows. Mouth large with a crescentic groove posteriorly, and two lateral lips. Peristomial segment without bristles, and so with the two following, the third bearing a pair of tentacles.

Body widens to the eighth or ninth bristled segment, is about two inches long; segments fifty, one-ringed. Branchiæ not observed behind the twelfth segment. Feet form lateral ridges with dorsal and ventral setigerous processes, and a minute flat intermediate papilla. A long dorsal tuft of capillary bristles, and a shorter one ventrally. A stouter series appears at the thirtieth foot. Posteriorly are elongated hooks with straight shafts and sharp curved tips.

Synonyms.

1893. *Cirratulus caudatus,* Levinsen. Kanonb. "Hauchs," p. 338.
1911. *Chætozone Dunmanni,* McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 160.

Habitat.—Dredged in Dunmanus Bay, Ireland, and now in the collection of the Royal Irish Museum. Levinsen found his examples in the Kattegat.

The *snout* (Plate CXI, fig. 3) forms a blunt cone, with slight lateral notches which may indicate sensory organs, and the peristomial segment is devoid of bristles. The mouth opens ventrally as a large aperture, having a crescentic groove posteriorly and a median furrow between the two lateral tips anteriorly.

From the peristomial segment the *body* gradually widens to the eighth or ninth bristled segment, and then rather abruptly dilates into an ovoid enlargement of ten segments, when it again contracts, such in all probability being due to the mode of preparation. The segments of the anterior region are distinctly marked and one-ringed, and the feet are represented by lateral ridges with dorsal and ventral setigerous processes and a minute flat intermediate papilla. Anteriorly the feet present, as at the sixth, a long dorsal tuft of capillary bristles and a shorter one ventrally (Plate CIX, fig. 14). This arrangement continues toward the thirtieth foot, when a stouter series appears—at first simply modified ordinary bristles with a double curvature of the shaft and a finely tapered tip, the ventral series apparently preceding the dorsal. Finally, posteriorly both divisions have the elongated and characteristic hooks (Plate CIX, fig. 14*a*). These have long, straight, finely striated shafts, which at the upper part have a slight bend forward, and then gently curve forward to the sharp tip, the striæ ceasing about the middle of the latter. They thus differ from the condition in *Chætozone* and approach that in *Cirratulus*.

I am indebted to Mr. Southern, who is specially engaged with the Cirratulids, for drawing my attention to the affinity of this form with Levinsen's *Cirratulus caudatus*, and there is certainly nothing in the description of the forms which seriously differs. No figures were given by the Danish author.

Genus CVII.—Dodecaceria,[1] *Œrsted*, 1843.

Head conical, mouth sub-terminal. Buccal segment with dorsal branchiæ and two grooved tentacles. Body linear, rounded. Filiform branchiæ placed singly on each side in five or six anterior segments, in some none, but the number is comparatively small. Feet with capillary dorsal bristles, and hooks inferiorly. No posterior appendages. Bristles partly capillary, partly short and thick, somewhat uncinate.

In *Dodecaceria concharum* the glandular hypoderm is largely developed, but the nerve-area is small and flattened, having to its exterior the slightly-developed circular muscular layer, the basement-tissue, the hypoderm, and cuticle. The longitudinal muscles are almost continuous, and proportionally thicker than in *Cirratulus*. The inner ends of the ventral come close to the nerve-trunks (Fig. 126).

Œrsted (1844) included *Dodecaceria* as one of the genera of his *Ariciæ lumbricinæ*, and Grube (1851) followed a similar arrangement in his ' Families of the Annelids.'

De Quatrefages (1865) adopted the *Heterocirrus* of Grube for this genus, and one of the generic characters was the presence of eyes, another the presence of a large tentacular cirrus above the branchiæ in the first segment. Moreover, he conserved the genus *Narganseta* of Stimpson, which does not appear to differ in any marked degree from *Dodecaceria*.

Monticelli (1891) gives a description of *Dodecaceria concharum*, stating that it is hermaphrodite, the male elements occurring first, and the female subsequently from the sixth segment backward.

[1] Δωδεκα and κεϕαια, antennæ?

1. Dodecaceria concharum, *Œrsted*, 1843. Plate XCI, fig. 3; Plate C, fig. 1—tenth bristle; Pl. CVII, figs. 7 and 7*d*—hooks.

Specific Characters.—Head more attenuated than the rest of the body, and the anterior border rounded.[1] Body about one inch long, or more, slightly tapered anteriorly, and more distinctly and gradually posteriorly. It is rounded throughout. Segments sixty-five. Tentacles twelve, commencing on the anterior part of the second segment, and the first are longer than the others, pale green or dull orange in colour, with darker pigment at the tip. Body brownish-red anteriorly, greenish-yellow posteriorly. The first seven feet have fascicles of capillary bristles dorsally and ventrally. The eighth has a few of the characteristic bill-hook crotchets ventrally amongst the bristles, and at the tenth the crotchets only are present. In the posterior region the dorsal division of the foot has a few

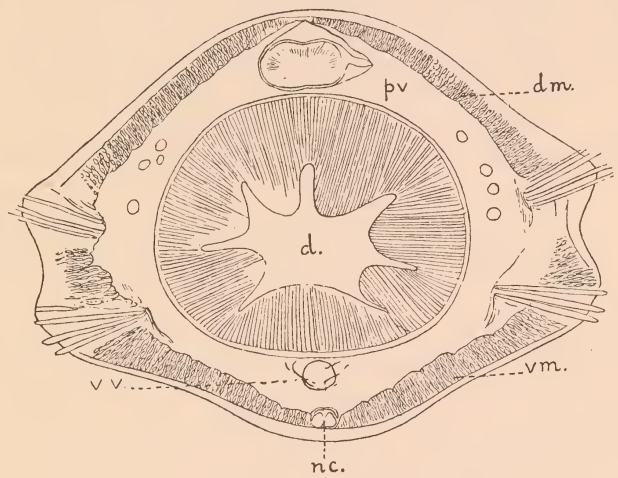

Fig. 126.—Transverse section of the anterior third of *Dodecaceria concharum*.

long capillary bristles, and short, stout, hook-like bristles bevelled at the tip—evidently modified crotchets. Ventrally are a few short bristles and one or two of the bill-hook crotchets.

Synonyms.

1822. *Nereis sextentaculata*, Delle Chiaje. Memorie, vol. iii, p. 176, Tav. xliii, fig. 16.
1841. „ „ idem. Descriz., vol. iii, p. 97, Tav. 105, fig. 16.
1843. *Dodecaceria concharum*, Œrsted. Annul. Danica Consp., p. 44, fig. 99.
1844. „ „ idem. Arch. f. Naturges., Bd. x, p. 109.
1851. „ „ Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 207.
„ *Cirratulus* „ Grube. Fam. Annel., pp. 68 and 134.
1853. *Terebella ostreæ*, Dalyell. Pow. Creat., ii, p. 209, pl. xxvi, f. 10.
1855. *Narganseta corallii*, Leidy. Invert. Rhode Island, etc., p. 12 (144), pl. ii, figs. 46—48.
„ *Heterocirrus saxicola*, Grube. Arch. f. Naturges., p. 109, pl. iv, fig. 11.
1861. *Cirratulus concharum*, Danielssen. Nyt Mag. f. Naturvid., Bd. xi, p. 52.
1865. *Dodecaceria concharum*, Johnston. Cat. Worms Brit. Mus., p. 202, fig. xxxviii.
1867. „ „ Malmgren. Annul. Polych., p. 96.
1868. „ „ McIntosh. Ann. Nat. Hist., ser. 4, t. ii, p. 286, pl. xx, figs. 1—4.
1873. *Heterocirrus saxicola*, Grube. Abh. Schles. Gesell. (1872), p. 7 (sep. cop.).

[1] Of four segments conjoined, Œrsted.

1874. *Dodecaceria concharum*, McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875. *Heterocirrus saxicola*, Panceri. Atti Soc. Ital., vol. xviii, p. 526.
,, ,, ,, Marion and Bobretzky. Ann. Sc. nat., 6e sér., t. ii, p. 67.
,, *Dodecaceria concharum*, McIntosh. Invert. and Fishes St. Andrews, p. 127.
1879. ,, ,, Tauber. Annul. Danica, p. 120.
1880. ,, ,, Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 96, Taf. iv, fig. 8.
1883. ,, ,, Levinsen. Vidensk. Meddel. Nat. Foren., p. 111.
1884. ,, ,, Webster and Benedict. Rep. Comm. Fish and Fisheries U. S. A. for 1881, p. 730.
1885. *Heterocirrus saxicola*, Carus. Fauna Medit., p. 248.
1888. *Dodecaceria concharum*, Cunningham and Ramage. Trans. Roy. Soc. Edinb., xxxiii, p. 647, pl. xxxix, fig. 12.
1894. ,, ,, Bidenkap. Christ. Vet.-Akad. Handl., p. 97.
1896. ,, ,, Monticelli. Boll. Soc. Nat. in Napoli., t. ix, p. 87 (1895).
,, ,, ,, Mesnil and Caullery. Comp. Rend. Acad. Sc., t. cxxiii, p. 511.
1897. ,, ,, Michaelsen. Polych. deutsch. Meere, p. 146.
1898. ,, ,, De St. Joseph. Ann. Sci. nat., 8e ser., v, p. 346, pl. xx, figs. 160, 161.
1904. ,, ,, Journ. M. B. A., vol. vii, p. 228.
1910. ,, ,, Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 237.
,, ,, ,, Elwes. Journ. M. B. A., vol. ix, p. 63.
1911. ,, ,, McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 156.
1914. ,, ,, Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 119.

Habitat.—Frequent under the roots of tangles (*Laminaria digitata*) especially when these have a crust of *Lithothamnion* beneath them, and in sandstone at the West Rocks, St. Andrews. (R. and W. C. M.); Howth, Dublin, and various localities on the west coast of Ireland (Southern); Torquay, in limestone boulders (Elwes).

Abroad it has been procured in Finmark and the shores of the North Sea (Malmgren, Tauber, etc.); Marseilles (Marion and Bobretzky); Adriatic (Grube); shores of France (De St. Joseph); Atlantic coast, U.S.A. (Leidy, Verrill, Webster and Benedict); Madeira (Langerhans).

Head (Plate XCI, fig. 3) more attenuated than the rest of the body, the anterior border being rounded, though capable of various changes of form. Mouth entering a little behind the tip inferiorly as a **Y**-shaped slit in which the action of the cilia is marked. A considerable amount of dark pigment occurs on the lips. The colour of the snout is dull greenish.

Body about an inch in length, slightly tapered toward the snout and more distinctly diminished toward the tail; more or less rounded throughout. When the animal is extended the anterior region of the body is nearly as narrow as the snout. Segments sixty. The tentacles are twelve in number, arise on the dorsal surface opposite each other, and the bases of the pairs approach quite as closely as in *Heterocirrus ater*. They commence at the anterior part of the second segment, the first pair being longer than the others. Dr. Johnston mentions the occurrence of eight. As a rule they are of a pale green colour, with darker pigment at the tip, but they may be dull orange. A coiled blood-vessel proceeds along the centre of each, and the edges are often crenated under examination, and when stretched out frequently show a dilatation at the tip. No cilia occur on them. When sickly the tentacles assume a dull brown hue.

In some the colour of the body is brownish-red anteriorly, greenish-yellow posteriorly, and streaked longitudinally with the red blood-vessel. In others touches of orange are present. The annelids dye spirit green and the body assumes a blackish-brown hue, paler posteriorly, the tip of the tail, however, becoming blackish-brown.

The first seven bristled segments have on each side two fascicles of simple bristles (Plate C, fig. 1) which taper to very delicate tips. In the eighth the ventral division shows a few of the peculiar bill-hook forms amongst the bristles, and at the tenth the crotchets only occur in the ventral division.

In some at the tenth foot the dorsal division has a few of the simple tapering bristles, and about three stouter bristles, the tips of which have been abraded so that an oblique surface remains at the end of the stump.

The typical hook (Plate CVII, fig. 7 *b*) has a slightly curved shaft which somewhat increases in diameter from the base to the distal third, then gently bends backward to the neck, where the dorsal line again has a backward curve, then forward to the tip. The anterior curve (which at the neck is also slightly backward) (Plate CVII, figs. 7 and 7 *a*) is abruptly broken by a bold conical projection, from the apex of which the distal curve runs to the stout tip. It thus differs in all respects from the tip of the southern *Dodecaceria ater*, De Quatrefages.

In the posterior part of the body the dorsal setigerous cone bears a few of the long slender tapering bristles and one or two short stout hook-like bristles bevelled at the tip, and representing a modified type of the ventral series. These modified hooks have no enlargement on the anterior face below the bevelled region. The ventral division likewise has a bristle or two of a shorter type than the dorsal, which are conspicuous in a lateral view from above, and one or two of the bill-hook crotchets, the only peculiarities being their shortness and the more marked curve of the less robust hook at the tip. The conical projection at the anterior base of the curve is distinct (Plate CVII, fig. 7 *d*).

In boring in sandstone, as at St. Andrews, the key-hole tube is lined by a calcareous secretion. Its habits are those of a true Cirratulid.

In a young example, 3 to 4 mm. in length, procured along with young *Arenicola*, the little boring *Sipunculus*, *Pholoë* and swarms of *Polydora ciliata* at the East Rocks St. Andrews, the body (in spirit) is rounded in front, but the posterior third is more or less flattened as in *Heterocirrus ater*. The colour of the two regions also differs, that in front being pale greyish, whilst the posterior is brownish-red. The bristled segments are about thirty-five in number. The snout is formed, as in the adult, with the mouth considerably behind the tip, and the tentacles and the branchiæ are well developed. The two rounded papillæ at the vent are more distinct than in the adult. The characteristic hooks show that whilst the flattened posterior region simulates that of *Heterocirrus ater*, yet this is an early condition.

Œrsted (1844) mentions that he found in an example two pairs of tentacles in the first segment placed one over the other, the lower much shorter and thicker than the upper. He notes that the species abounds in oyster-shells along with *Cliona*, and that perhaps the alimentary chyme (which contains muriatic acid) and the ventral hooks aid in the perforations.

Dalyell (1853) procured about a dozen in a single oyster-shell, and he thought each "capable of forming an enlarged cavity for its own lodgement—it may be by some solvent, and the tube is lined with silk."

Monticelli states that this form is a protandrous hermaphrodite in the Mediterranean, but Caullery and Mesnil do not confirm this in the case of specimens in the Channel, where it shows an epitokous condition. On the other hand, in a female example procured by De St. Joseph, and also in one procured by Langerhans, no trace of an epitokous condition was present.

Cunningham and Ramage[1] (1888) observe that *Dodecaceria* differs from *Chætozone* in (1) the absence of the peculiar arrangement of hooks posteriorly, and (2) in having but a few pairs of branchial cirri and only on the anterior somites. They found it in roots of Laminariæ at Granton, not in shells as Johnston did.

A remarkable case of abnormal regeneration of this species is recorded by Caullery and Mesnil[2] (1897) in which what they supposed to be a fragment of the middle of the body reproduced at the anterior end a head and eleven setigerous segments, as well as a tail on the right side of the cicatrix of thirty-two segments; whilst the posterior end of the original fragment developed a tail of thirty-one bristled segments. The same talented authors represent the gonaducts of this species as simple funnels opening externally by pores. They also found Gregarines in the digestive tube, viz. *Selenidium* and an *Opalina*, probably *O. lineata* (*Haplitophryæ*, Stein).

It is possible that further examination of the American forms of this and other Cirratulidæ may reveal closer relationship with the British forms than Verrill thinks.

Genus CVIII.—Heterocirrus, *Grube*.[3]

Head devoid of appendages; with or without eyes; first bristled segment bears a pair of large grooved tentacles and a pair of branchial filaments slightly above and behind them;[4] a pair of lateral branchiæ on many of the succeeding segments, but they are rare or cease altogether posteriorly. Capillary bristles and crotchets or capillary bristles only.

In *Heterocirrus ater* (Fig. 127) the deeply pigmented hypoderm, which is specially thickened in the mid-ventral region, rests on a thin basement-layer with a few circular fibres internally. The nerve-cords lie at the inner border of the hypoderm, and are more distinct than in *Dodecaceria concharum*. Moreover, a large neural canal is situated in the centre superiorly. The large oblique muscles are attached over the ovoid area of the cords and cover each slope of the area completely. The ventral longitudinal muscles apparently are the thicker. In transverse section they taper as they approach the nerve-area. The dorsal sinus or blood-vessel is generally largely dilated and filled with granular contents. Large blood-vessels occur inside the body-wall all around, and are especially conspicuous

[1] 'Trans. Roy. Soc. Edinb.,' vol. xxxiii, p. 647, pl. 39, fig. 12.

[2] 'Zool. Anzeiger,' Bd. xx, p. 438, three text-figs.

[3] This genus is conserved with hesitation, for all the species might fall under *Dodecaceria*.

[4] Carus says, "between which a short papilliform process occurs."

ventrally. So far as the structure of the body-wall goes, this form closely approaches *Dodecaceria*.

1. Heterocirrus ater, *De Quatrefages*, 1865. Plate CVII, fig. 8—8 *b*—bristle and hook.

Specific characters.—Head cylindrical, rounded in front, numerous small eyes in a band on each lateral region sloping from within outward and forward about the middle of the head. First four body-segments are short and bear pale green branchiæ. The buccal segment carries the large, long grooved tentacles and a branchia immediately above and behind. The next four segments have branchiæ on the dorsum. Body 1 to 2 in. long, rounded in front, flattened posteriorly; the caudal region being oar-shaped, and rather abruptly narrowed to two papillæ at the tip, with the anus between. Colour dark blackish-green. Behind the tentacles are indications of five segments, four bearing

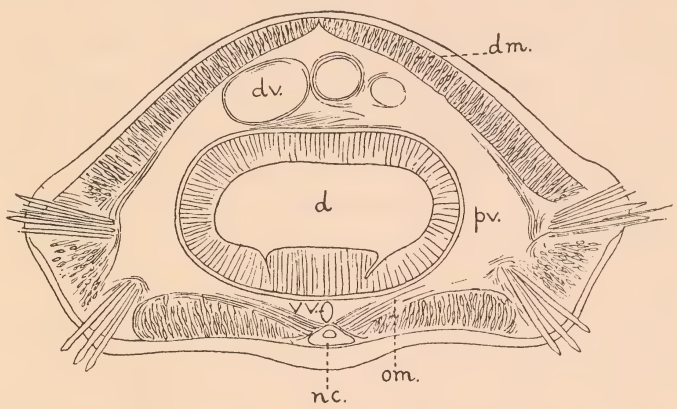

Fig. 127.—Transverse section of *Heterocirrus ater*, De Quatrefages, from Guernsey. Oc. 2, obj. A.

capillary bristles dorsally and ventrally. At the seventh segment the characteristic crotchets occur in both dorsal and ventral divisions. Each crotchet has a shaft dilating from the base upward a short distance, then remaining of nearly equal diameter to the neck where it bends backward and again forward at the tip, which in certain views shows a median rib and two expanded lateral areas, but in lateral view it resembles an old snuff-spoon. Toward the tip of the tail these crotchets are of great proportional strength.

Synonyms.

1841. *Nereis sextentaculata*, Delle Chiaje. Descrizione, Tav. cv, fig. 16.
1865. *Heterocirrus ater*, De Quatrefages. Annel., i, p. 465, pl. x, figs. 13—17.
1894. „ „ De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 52.
1911. *Dodecaceria ater*, McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 158.

Habitat.—Abundant in the thick coating of *Lithothamnion* covering the gneiss rocks at low water, and in the cracks of rocks in long galleries, bent in various ways—though generally doubled—in Guernsey and Herm. Shores of France (De Quatrefages, etc.).

Head rather elongated like that of *Phyllodoce*, slightly tapered and smoothly rounded in front, and with two dark patches of minute eyes on the dorso-lateral region of its middle, the snout in front of them often being pale in the preparations, whilst that behind

is dark. The mouth opens ventrally a short distance behind the tip of the snout as in other forms, and not at the tip as De Quatrefages observes.

Body 1 to 2 inches in length, rounded or slightly flattened in front, more distinctly flattened after the anterior third, and often showing a broad oar-shaped outline posteriorly before abruptly narrowing to the tip, which presents a papilla on each side at the vent. The body is slightly tapered toward the snout, and the segments throughout are distinctly marked, their antero-posterior diameter being larger in front than behind. The first four or five bristled segments are narrow. The dorsal and ventral divisions of the feet are evident.

The colour is very dark blackish-green throughout, the tentacles being pale green with a central red streak. It tinges spirit green, giving out a dark green exudation just as dark green specimens of *Cirratulus* do.

In the intestine of an epitokous form fragments of fine algæ were present.

De Quatrefages thought that the buccal segment was in abeyance (" L'anneau buccal a presque entirèment disparu"), but not only the mouth-parts but also the origin of the great tentacles probably pertain to the peristomium. The large tentacles are prominent organs with a deep groove on their ventral surfaces, the edges of which in the preparations are crenated, and thus in all probability they approach in function to those of *Polydora* and other Spionidæ. Above and behind the tentacles is a branchia, and as a rule three others follow, each on the dorsal arch of its segment, and with a diminishing transverse distance between the bases. They are of moderate length, and in some have a tendency to form curves and a few coils.

Behind the tentacles are indications of five segments, but whether the imperfect first of these should be regarded as an independent one may be an open question. The four following have dorsal and ventral bristles of a simple tapering kind minutely serrated along the anterior edge (Plate CVII, fig. 8). These and the next are all narrow segments and differ in this respect from those which follow. The first is represented by a dorsal and a ventral setigerous papilla with a ridge between.

This type of foot changes at the seventh, where the characteristic hooks or crotchets occur in the ventral as well as in the dorsal division. On their first appearance these organs have a slight forward bend of the shaft as far as the distal third, where a faint backward curve takes place. The shaft shows only a slight dilatation from the base a short distance upward, remaining nearly of the same diameter to the neck, where it bends backward and again forward at the tip. The tip in certain antero-posterior views shows a median rib and two lateral wing-like areas, but probably this appearance is due to the thicker tissue in the centre and the thinner and slightly expanded lateral regions. In lateral view (Plate CVII, fig. 8 *a*) the hollow of the distal hook appears to be scooped out like the old snuff-spoon, while an antero-posterior view shows a bluntly-conical point (*ibid.*, fig. 8 *b*). These hooks increase gradually in strength though not in length posteriorly in both divisions of the foot, and their number toward the tip of the tail diminishes, but they are of great proportional size. Two occur in the dorsal and three in the ventral division just in front of the tail, but the number seems to vary. The alterations of the contour of the tips of these hooks would indicate that they have special functions in connection with the tunnel, and their gradual increase in strength from

before backward is corroborative of that view. In some the tips are spatula-shaped, a slight constriction occurring at the neck. One or two capillary bristles, with a slight flattening of the serrated tapering tip, accompany the dorsal hooks.

Reproduction.—Several procured at Guernsey and Herm in July and August had well-developed eggs. Moreover, an epitokous example (male, more than 2 inches long) occurred amongst the others at St. Peter Port, Guernsey. In this the anterior region of about thirty segments is modified, whilst the caudal of about thirty segments does not present a noteworthy change. The pigmented area of the eyes is perhaps a little larger, and the dorsal tuberosity of the head somewhat more prominent, whilst the tentacles and branchiæ are normal. The whole of the anterior and middle regions are enlarged, softer, and have long resplendent dorsal swimming bristles, which exceed in length the diameter of the body. They are smooth simple tapering bristles, with very faint longitudinal lines, and of a pale yellow hue, best seen by transmitted light, and their tips are remarkably attenuate. The anterior dorsal bristles are not much changed, but from the eighth to the thirty-first they form conspicuous tufts on each side. This bristled region with the head is probably thrown off and emits the sexual elements, whilst the unchanged and flattened posterior moiety of about thirty segments reproduces a head and anterior region. The fact that this example, which was not quite ripe, still occupied its tube in *Lithothamnion*, would indicate that up to the period of "swarming" the oar-shaped posterior region and its series of powerful hooks would be of material service to the form, and, further, after the separation of the sexual region, if such is found to occur, the remnant would be ready for the exigencies of its life in the calcareous crusts and masses. The great size of the hooks or crotchets throughout, and especially in the posterior region, shows that the form is adult, and that the shovel-shaped and abraded posterior hooks have been in constant use. In the dorsal division (with two hooks) are one or two of the tapering capillary bristles, the anterior edge of the tip of each of which is serrated.

The *Heterocirrus saxatilis* of Grube[1] (1855) may be the same or an allied form, and the same may be said of his *Heterocirrus multibranchis*[2] (1863).

De St. Joseph (1894) describes three new species from Dinard on the French coast, each apparently differing from the other in the distribution of the bristles and in coloration. It is possible that further study may simplify the series.

Heterocirrus fimbriatus, Verrill, is the pelagic form of *Dodecaceria concharum*. According to Caullery and Mesnil, Langerhans again shows a young form of B. (small pelagic). The species is polymorphic in its sexual phases.

2. Heterocirrus viridis, *Langerhans*, 1880. Plate CXI, fig. 9—head, and figs. 9 *a*, 9 *b*—bristle and hooks.

Specific characters.—Head forming a more or less acute, but flattened cone with two large eyes placed over the posterior region of the cerebral ganglia. Nuchal organ on each side a little behind the eye. Two achætous segments follow, the second, that behind the

[1] 'Arch. f. Naturges.,' Bd. xxi, p. 109, Taf. iv, fig. 11.

[2] Ibid., Bd. xxix, p. 49, Taf. v, fig. 2.

peristomium, bearing two large muscular and grooved tentacles, and a pair of branchiæ beneath them.

Body about half an inch long, and having from fifty to eighty-six segments. The third segment bears bristles, and the third bristled segment has ventrally bifid hooks, which continue to the posterior end. The dorsal bristles likewise occur throughout except near the anal segment, where two hooks occur with them and dorsal bristles. Colour greenish or yellowish.

Hooks with a large and not very acute main fang, a spike above it, a slightly curved shaft with an enlargement at the shoulder.

Synonyms.

1880. *Cirratulus viridis,* Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 98, Taf. iv, fig. 9.
1894. *Heterocirrus flavoviridis,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xviii, p. 54, pl. iii, fig. 61.
1898. „ „ Caullery and Mesnil. Annales Univ. Lyon, fasc. xxxix, p. 117.
1910. „ *viridis,* Elwes. Journ. M. B. A., vol. ix, p. 63.

Habitat.—Occasionally in small pools in limestone rocks at Babbacombe (Elwes).

The *head* forms a more or less pointed cone with two conspicuous eyes posteriorly.

The *body* in the preparation is thickest anteriorly, tapering only a little to the conical snout. It is about half an inch in length, and has from fifty to eighty-six segments. It tapers gradually from the anterior region to the tip of the slender tail which has the anus at the tip. It is characterised by the numerous filaments which stretch on each side from the tentacles backward, and which give it a woolly appearance. The colour is greenish or yellow, though in the preparation it is blackish. The tentacles are long, grooved, ciliated, and can be moved actively or coiled in a spiral; whilst beneath each is a branchial filament. The next two segments (third and fourth) bear bristles both dorsally and ventrally and they curve backward. In the following segment bifid crotchets appear in the ventral division, and are continued to the posterior end. At the thirteenth segment four of the five capillary bristles disappear, and two hooks of the same structure as the ventral accompany the single bristle to the posterior end (De St. Joseph). The bristles are longest anteriorly, and soon become short and thus are in marked contrast to those of certain forms, the long caudal bristles of which are so conspicuous, yet they are also directed forward. De St. Joseph thought that it agreed with *Heterocirrus caput-esocis* in its segmental organs and anal segment. Further that it approached the *Heterocirrus* (*Cirratulus*) *fragilis* of Leidy, and the *Cirratulus viridis* of Langerhans, both of which had eyes and bifid hooks, but the tentacles in the former arise on the second setigerous segment and in the latter on the first setigerous segment. There is little doubt that the species of Langerhans is identical with that of De St. Joseph.

This is one of the species which the patient and acute Baron de St. Joseph added to the French fauna from the shores of Dinard, which he has made classic by his able researches on the annelids. It appears to be a southern type, and a single example was procured by Major Elwes, who kindly presented the mounted preparation.

In *Heterocirrus viridis* MM. Caullery and Mesnil discovered a *Haplosporidium* (*H. heterocirri*)—probably in the perivisceral cavity. Mesnil again (1901) witnessed regeneration of the anterior region in the same species.

3. Heterocirrus caput-esocis, *De St Joseph*, 1894. Plate CXI, fig. 10—hook.

Specific Characters.—Head forming a blunt cone like that of a pike, with two large eyes placed over the posterior ganglionic region. Nuchal organs occur at the sides behind the eyes. Proboscis short and bilobed.

The body is larger than in the previous form, measuring 15 to 17 mm., and having about eighty-four segments (De St. Joseph). Posteriorly it terminates in a conical tip, the anal segment having at its base five festoons ventrally (De St. Joseph). In the fragmentary example it tapered much anteriorly. The buccal and the next segment are achætous, the latter giving rise to the large tentacles, with a branchia beneath each. Bristles commence in the dorsal division on the third segment, and continue nearly to the tail. Beneath the dorsal bristle-tuft is a pair of slender, long branchiæ. The dorsal bristles are joined in the last twenty-three segments by several of the peculiar hooks (acicular bristles, De St. Joseph). The first ten or twelve bristled segments have capillary bristles in both divisions; thereafter the modified hooks take their place in the ventral division. Hooks *f*-shaped with a curved distal region, which has a slight hook at the tip.

Synonyms.

1894. *Heterocirrus caput-esocis*, De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 53, pl. iii, figs. 58—60.
1898. „ „ Caullery and Mesnil. Annales Univ. Lyon, fasc. xxxix, p. 122.

Habitat.—In small pools in limestone rocks at Babbacombe (Elwes).[1]

The *head* forms a rounded cone like that of a pike in life (De St. Joseph), and has two conspicuous eyes, and behind them laterally the nuchal organs.

The *body* ranges from 15 to 17 mm. or more in length, is more or less tapered anteriorly, and still more so posteriorly, where it ends in a conical tip, the anal segment having five "festoons" at its base ventrally. The anterior bristles are less conspicuous than in *H. viridis*, but they occur in both divisions in the anterior ten or twelve segments. Thereafter the dorsal bristles continue to the end, being joined in the last twenty-three segments by one to four acicular bristles smaller than those in the ventral division. The ventral acicular bristles or hooks (Plate CXI, fig. 10) quite differ from those of any allied species, being *f*-shaped, with a hook at the distal extremity.

De St. Joseph found ripe males and females, the latter with greyish eggs 0·12 mm. in diameter. They occurred between the fourteenth anterior segment and the eighteenth from the tip of the tail, and the ripe forms developed long bristles. He describes a pair of large segmental organs in the first five bristled segments, opening externally on the ventral surface of the first setigerous segment. Of the two ciliated internal branches one is uncoloured, with a ciliated funnel in the second setigerous segment, and the other, coloured brown, communicates with the external pore.

Genus CIX.—Chætozone,[2] *Malmgren*, 1867.

Head without appendages. A pair of large tentacles springing from the dorsum of the next (buccal) segment, and accompanied by a branchia on each side. A considerable

[1] I am indebted to the courtesy of Major Elwes also for this example.

[2] χαίτη ἡ et ζώυη ἡ.

number of the following segments have a branchia on each side, just above the dorsal bristle-bundle. Only capillary bristles in front. Crotchets occur dorsally and ventrally posteriorly.

The family has a wide distribution, ranging on the east to Japan and on the west to America.

Mayer[1] describes *Chætozone* as having five cerebral ganglia, and Racovitza agrees.

It is difficult to make out what the forms named *Cirratulus abyssorun* and *C.* (*?*) *abranchiata* really are, since the structural details given by Hansen[2] are too few.

1. Chætozone setosa, *Malmgren*, 1867. Plate CVII, fig. 4—dorsal bristle.

Specific characters.—Head acutely pointed and conical; two long grooved tentacles arise immediately behind. Body about an inch in length, elongate fusiform, tapering a little anteriorly and more gradually and distinctly posteriorly, terminating in a pointed tail with the anus at the tip.

Long slender branchiæ occur in pairs, one on each side, probably from fourteen to twenty in succession, and then at intervals to the posterior third. Feet anteriorly have dorsally and ventrally capillary bristles with cylindrical shafts, and flattened serrated tip tapering to a fine point. The dorsal tuft becomes longer than the ventral about the twentieth, and nearly equals the diameter of the body. Posteriorly crotchet-like forms appear in the ventral and then in the dorsal division, so that the last fifteen are well armed. The fully-developed crotchet dilates a little from the base upward, then is constricted about the level of the skin from which a noticeable bend forward occurs, the long, stout slightly tapered tip ending in a blunt point. It is striated almost to the point. The crotchets form a dense fringe to the final segments.

Synonyms.

1867.	*Chætozone setosa,*	Malmgren.	Annul. Polych., p. 96 (206), Taf. xiv, fig. 84.
1869.	,,	,,	Sars. Christ. Vid.-Selsk. Forhandl., Aar. 1868, p. 253.
1873.	,,	,,	idem. Bidrag Christ Fauna, p. 74, and in Nyt Mag. f. Naturvid., xix, p. 274.
1879.	,,	,,	Tauber. Annul. Danica., p. 120.
,,	,,	,,	Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 54.
1883.	,,	,,	Levinsen. Vidensk. Meddel. Nat. Foren., p. 111.
,,	,,	,,	Wirén. Chætop. 'Vega' Exped., p. 410.
1886.	,,	,,	Levinsen. Kara-Havets Svampe, p. 9.
1888.	,,	,,	Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 647, pl. xxxix, fig. 11.
1889.	,,	,,	Marenzeller. Arch. f. Naturges., Bd. lv, p. 132.
1890.	,,	,,	Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 254.
1894.	,,	,,	Bidenkap. Christ. Vid.-Selsk. Forhandl., 1894, no. 10, p. 98.
1897.	,,	,,	Michaelsen. Polych. deutsch. Meere, p. 146.
1898.	,,	,,	idem. Grönländ. Annel., p. 128.
1907.	,,	,,	Fauvel. Bull. Inst. Ocean., No. 107, p. 18.

[1] 'Mitt. Zool. St. Neapel,' Bd. viii, pp. 462—662, pls. xxiii—xxv.

[2] 'Nyt Mag. f. Naturvid.', xxiv, Bd., p. 10.

1909. *Chætozone setosa,* Percy Moore. Proc. U. S. Nat. Mus., vol. xxxvii, p. 139.
1911. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, pp. 165, 166, 169, and 170.
1913. „ „ Augener. Zool. Anzeiger, Bd. xli, p. 261.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 119.

Habitat.—Station 7 (1890) S.W. Ireland (R.I.A.); Clare Island district (Southern). Abroad it is noted from Greenland (Michaelsen); Spitzbergen, Norway, Sweden, and Finmark (Malmgren); Spitzbergen (Fauvel). Abundant in the Fjords of Norway, such as Lervig Bay, off Dröbak, etc. (coll. A. M. Norman); 300 fathoms, off Norway (Sars); Atlantic coast, U.S.A. (Verrill); Siberian and Behring seas (Wirén); Kara-Havets, etc. (Levinsen); Franz-Joseph Land (Augener).

Head acutely pointed and somewhat triangular, with the mouth on the ventral surface (of the peristomium) a short distance from the tip.

Body about an inch in length, elongate-fusiform, tapering a little anteriorly and more gradually and distinctly posteriorly, where it terminates in a pointed extremity with the anus at the tip, which varies in acuteness according to the condition of regeneration, some being rather blunt after recent loss of segments. The thickest part of the body is about the end of the anterior third. It is more or less rounded throughout, with a tendency, however, to dorsal and ventral flattening. The segments number seventy to ninety, and are narrow in front, but more evident posteriorly, where their antero-posterior diameter is greater. The surface is greyish in the preparations and is iridescent. The long tentacles arise on the dorso-lateral region immediately behind the head, and seem to be rarely present in dredged examples. They have the ventral and probably ciliated groove of other forms. The branchiæ occur in pairs, one on each side, probably from fourteen to twenty in succession, and then at intervals to the posterior third. They are slender filaments, those in front being long and sinuous.

The first bristled foot occurs behind the tentacles, and has a dorsal and a ventral tuft of pale golden capillary bristles with a more or less cylindrical shaft generally inserted in the tissues, and a broader, flattened, serrated tip, which tapers to a fine point. In the anterior region little difference exists between the length of the dorsal and the ventral bristles, both of which are directed backward, but after the twentieth or thereabout the dorsal become more elongate, forming glistening tufts, usually borne transversely in the preparations, and almost equalling in some the diameter of the body.

Toward the posterior region stout, short, crotchet-like forms appear in the ventral and then in the dorsal amongst the longer bristles. They are more slender in the dorsal than in the ventral, and the dorsal bristles are fewer in number and proportionally more attenuate, only a brief flattened part occurring beyond the skin, the rest being hair-like. Moreover, the ventral bristles present intermediate forms, the shafts being about three times the diameter of the ordinary bristles, then a slight constriction occurs at the level of the cuticle, the tip being broad and more or less striated, but terminating in a long hair-like process.

The perfect organ (crotchet-like or acicular bristle) is best seen in the posterior region, comprising about fifteen segments, where it is in full strength (Plate CVII, fig. 4). The shaft dilates a little from the soft base upward, then narrows slightly about the level of the skin, from which a noticeable anterior bend occurs, the long, stout tip ending in a blunt point. The whole organ is striated almost to the point and somewhat resembles a

miniature scalpel, the blade of which has a curve backward. The direction of these crotchets is at first slightly backward, but by-and-by they project transversely outward, and in four or five of the terminal segments they are directed forward, doubtless in connection with their functions in the mud or sandy mud.

Two fragments of the anterior region of a form which does not appear to differ from the foregoing were procured, probably by the tangles in Bono Bay, on the coast of Algiers in the 'Porcupine' expedition of 1870. As no crotchets are present, a certain amount of doubt remains, the bristles at the posterior end of one fragment being unusually long, and their bases of a deep brown hue.

Cunningham and Ramage (1888) note that the anterior pair of brown nephridia open at the base of the first pair of feet and extend backward through two or three segments. The heart-body consists of three granular cords, as in *Cirratulus*.

Reproduction.—Partially developed eggs occurred in the perivisceral cavity of an example captured in July. In Norwegian examples large ova were present during the same month.

Marenzeller (1889) thinks that the branchiæ are most frequently behind the tentacles. The point at which the row of dorsal bristles joins the ventral, and the shorter and stouter bristles in a half circle (Halbgürtel) is in the sixty-seventh or in some the seventy-fifth bristled segment.

2. Chœtozone zetlandica, *McIntosh*, 1911. Plate CVII, figs. 5 and 5 *a*—bristle and hook.

Specific Characters.—Head pointed in front, swollen behind, with a pair of kidney-shaped ventral eyes, and externally the nuchal organs.[1] Dorsal tentacles in front of first bristles. Body distinguished from that of *Chætozone setosa* by its flatness, the more hirsute lateral regions, the button-shaped anus, and the absence of the differentiated posterior region. Feet at the anterior part of the fragment have a few long and finely-tapered capillary bristles, and a series of broad, flattened bristles, curved and faintly striated, and with tapered extremities. Ventral division with a few shorter capillary bristles, and a shorter series of the same curved, flattened, faintly striated bristles, with tapering tips as in the dorsal division. In front of the tail the dorsal division has a few long, tapering capillary bristles, the main series, with a nearly cylindrical shaft inserted in the tissues, constricted before passing through the skin, after which it curves forward and ends in the long, flattened, curved and tapering tip. The ventral division has shorter capillary bristles of the same kind, and a series of stouter crotchets with flattened shafts, and slightly narrowed curved tips with a blunt point.

Synonyms.

1911. *Chætozone zetlandica,* McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 161.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 115, pls. xii and xiii, fig. 29, A—K.

[1] The capture of perfect forms by Mr. Southern in the Clare Island district has enabled me briefly to supplement the description.

Habitat.—Dredged in 100 fathoms, St. Magnus Bay, Shetland, in July, 1867, by Dr. Gwyn Jeffreys; between tide-marks, in clear sand, Clare Island district (Southern).

The original example was a fragment, about half an inch in length, of the middle and posterior regions, including more than sixty bristled segments, which differs from *C. setosa* by the flattened body, longer lateral bristles, the button-shaped anus, and the absence of the differentiated posterior region so characteristic of the species just mentioned.

The broad, flattened body, 44 mm. long in the complete form, has 150 very distinct segments, with setigerous papillæ projecting as conical eminences. The posterior end seems to have been reproduced, about fifteen segments being thus added, with the large button-shaped pygidium; but the general structure of the feet remains as in front, and it differs from the condition in *C. setosa*, in which the modification of the crotchets in the posterior region is characteristic.

The feet at the anterior part of the fragment (Plate CVII, fig. 5) have dorsally a few finely-tapered capillary bristles and a series of broad, flattened bristles, curved and faintly striated, and with tapered extremities. They represent the intermediate forms ushering in the anterior crotchets of *C. setosa*. The ventral division consists of a few shorter capillary bristles and a still shorter series of the same curved, flattened, faintly striated bristles, with tapering tips as in the dorsal division. In front of the reproduced tail the dorsal division has a few long, tapering, capillary bristles, the main series, however, consisting of long, stiff, curved, and striated forms, with a nearly cylindrical shaft inserted in the tissues, a constriction being evident before passing through the skin, after which it curves forward, and ends in the long, flattened, curved, and tapering tip. The ventral division, again, has shorter bristles of the same kind as the foregoing, besides a series of stouter crotchets, which have flattened shafts inserted in the tissues, and slightly narrowed curved tips tapering to a blunt point (Plate CVII, fig. 5 *a*).

This form, therefore, appears to pertain to De St. Joseph's second series, viz. those with capillary bristles in the dorsal throughout, and crotchets in a certain number of the ventral divisions of the feet, but the absence of reliable figures in known forms makes its relationship uncertain.

Reproduction.—The fragment pertained to a female with ova of uniform size in the perivisceral space, besides many smaller in the ovaries. It was procured in July. Southern found the young pelagic in March and August.

3. Chœtozone Z. Plate CIII, fig. 17—bristles.

1911. *Chœtozone Z*, McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 167, pl. vi, fig. 6 *a*.

As no locality is given in the case of a fragment dredged in the 'Porcupine' expedition of 1870, it may be noted that it has a gradually widening and spatulate tail, which is bluntly rounded, with a median ridge dorsally and ventrally, the former curving downward to terminate in the ventral anus, which has a peak anteriorly. The region in front is considerably narrower, the dorsal surface being rounded, the ventral flattened. The segments are numerous and narrow, and have dorsal and ventral tufts of slender capillary bristles (Plate CIII, fig. 17) of a pale yellow colour and nearly straight.

Genus CX.—Cirratulispio, *McIntosh*, 1911.

Elongated filiform annelids with conical prostomium. Two long tentacles from the first bristled segment. Body of an anterior region of nine narrow bristled segments with capillary bristles, followed by a second region of wide segments and rows of crotchets with interspersed capillary bristles.

1. Cirratulispio Caulleryi,[1] *McIntosh*. Plate CI, fig. 1—head; Plate CVII, figs. 14 and 14 *a*—bristles and hook.

Specific Characters.—Head bluntly conical, and the sides of the cone slightly hollowed. Pair of slender tentacles from the buccal segment, which bears bristles. Body elongated and filiform, probably 2 to 3 in. long, of two regions, the anterior with nine pairs of golden bristles, and a succeeding region with broader segments.

Anterior foot with a dorsal and a ventral tuft of moderately long, golden capillary bristles with a convergent curve, the dorsal being longer than the ventral. The foot of the second region has dorsally two smooth capillary bristles, followed by five or six crotchets with the tips produced into slender processes, and then a series of strong, curved crotchets, with stout, pointed tips, bristles being interposed.

Tubicolous ?

Synonym.

1911. *Cirratulispio*, McIntosh. Ann. Nat. Hist., ser. 8, vol. vii, p. 167, pl. vi, fig. 7, pl. vii, figs. 7*a*, 7*b*.

Habitat.—Dredged in the 'Porcupine' expedition of 1869 in 378 fathoms in sticky mud off the coast of Ireland. The mud contained fragments of Foraminifera, Coccoliths, and sandy *débris*.

The *head* (Plate CI, fig. I) is bluntly conical and the sides of the cone are slightly hollowed. A pair of slender tentacles pass from the bristled segment immediately behind and therefore apparently posterior to the buccal ring, though fusion may exist.

The *body* is filiform and elongated, probably 2 to 3 in. in length, apparently tubicolous, and it is imperfect posteriorly; but at least two regions are recognisable—namely, the anterior with nine pairs of well-marked pale golden bristles, and the succeeding division.

The first region agrees with the Chætopterids in the number of the segments (nine), and each foot has a dorsal and a ventral tuft of moderately long capillary, pale golden bristles (Plate CVII, fig. 14) which have a slight convergent curve—that is, the dorsal bending downward and the ventral upward. Both arise close together in the tissues, then slant from each other so that a flat cone in the middle of the foot lies between them. The dorsal tuft is considerably longer than the ventral, but the structure of the bristles is the same in both. Each bristle has a long cylindrical shaft not differentiated from the tip, and gradually tapers to a fine point from its middle, though in the shorter ventral forms there are differences in this respect.

[1] Named after the distinguished Professor of Evolution in the Sorbonne, who has advanced our knowledge of the group in a noteworthy manner.

No special differentiation separates the first region of the body from that which follows, and therein it differs from the Chætopterids; but the first segment of the succeeding region is three times broader (antero-posteriorly) than those in front, and its bristles are shorter and structurally different, whilst each of the two divisions carries a continuous row of stout, curved crotchets without the differentiation between shaft and tip as observed in *Chætozone* (Plate CVII, fig. 14 *a*—representing one from the tenth foot). Dorsally are two smooth capillary bristles, followed by five or six crotchets with the tips produced into slender processes, and then a series of the stout, curved crotchets with slightly tapered tips ending in a stout, though more or less pointed, tip. The arrangement of these crotchets recalls the condition in *Chætozone setosa*, bristles being also interposed between the crotchets in the rows.[1]

Family XXIII.—Capitellidæ, *Grube*; Halelminthidæ, *Malmgren*; Halelminthea, *V. Carus*.

The cephalic region is pointed, and has two relatively small balaniform (nut-shaped) retractile tentacles. Eyes in the form of pigment-specks. The peristomial segment is devoid of bristles. An eversible, papillose, and boring proboscis issues from the ventral mouth. Body long, reddish, rounded, with distinct segments, and of two regions—the first of nine to fourteen segments and a cuticular mosaic, with rudimentary feet and capillary bristles; the second with slightly retracted rows of hooks, and terminating posteriorly in an anus with papillæ. Branchiæ at the ends of the rows of hooks in the posterior part of the body, conspicuous or partially or wholly retractile, and containing hæmolymph (cœlomic fluid), the corpuscles being coloured, the plasma colourless. Sense-organs and ciliated organs present. In most of the segments side-organs in a groove on the anterior region, free on the posterior region. Cup-like organs on the proboscis, head, and body. Cephalic ganglia and œsophageal ring in the head and first two body-segments, followed by nerve-cords which lie free on the body-cavity, the oblique muscles descending beneath. The only circulatory system is the hæmolymph in the cœlom. Segmental organs in most segments, or confined to a region.

Sexes separate. Reproductive organs consist of genital pouches and copulatory organs in the male, with vesiculæ seminales and penes with strong hooks; in the female, ovary, receptacula seminis, and vulvæ. Larva free with metamorphosis. They live in sand and mud into which they bore.

In *Notomastus latericeus* the type of the body-wall differs much from that of the Cirratulidæ, and, besides, the longitudinal muscles are asymmetrical, for a median muscle of great power occurs in the mid-ventral line (Fig. 128), and thus the nerve-cords are borne inward to its upper surface. Externally are the cuticle and moderately developed

[1] Whilst this sheet is passing through the press Mr. Southern has considerably added to our knowledge of the Cirratulidæ of the west coast of Ireland. Thus he describes *Cirratulus McIntoshi* (= *C. norvegicus*, McIntosh), *Chætozone alata*, n.s., *C. Killariensis*, n.s., and *Macrochæta clavicornis*, Sars. 'Proc. Roy. Irish Acad.,' vol. xxxi, no. 47, pp. 110—120, pls. xii and xiii. These and other additions to the Polychæt Fauna will subsequently be noticed.

hypoderm, which is somewhat thicker on the ridge in the mid-dorsal line, and on each side of the mid-ventral muscle. The hypodermic basement-tissue seems to be feebly developed, for the hypoderm proper clings closely to the well-developed circular muscular layer which lies within it, and encircles the body. In the mid-dorsal line beneath the hypodermic ridge is a special series of short transverse fibres outside the ordinary circular layer, but certain fibres

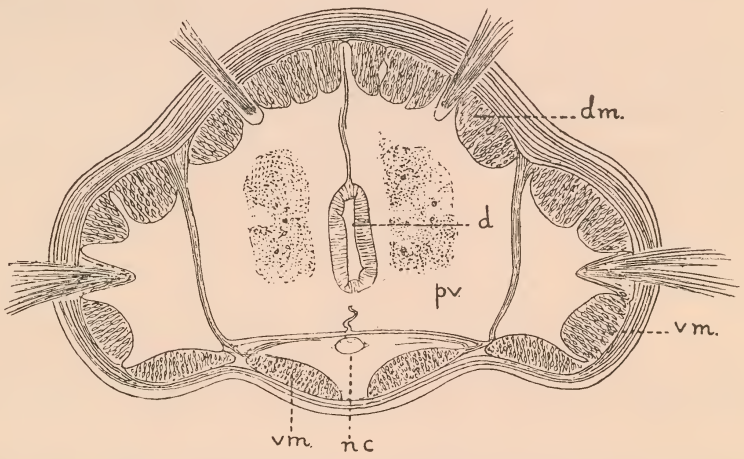

Fig. 128.—Transverse section of the anterior region of *Notomastus latericeus*, Sars. Letters as before.

of which seem to run into it. Immediately within the continuous circular coat is a pair of small and symmetrical longitudinal muscles, which in transverse section are elongate-ovoid with the more acute end external, though the appearance varies according to the preparation. They are covered internally by connective tissue and cœlomic epithelium, and at the outer end of the pair is the attachment of a powerful vertical band of muscular

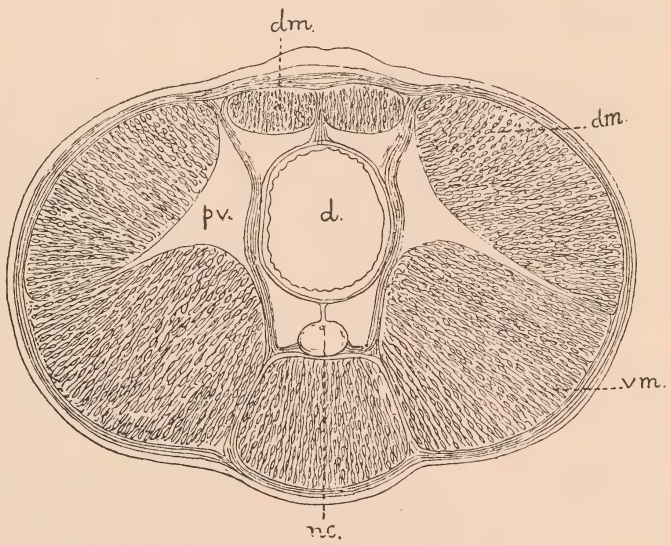

Fig. 129.—Transverse section of the posterior region of *Notomastus latericeus*, Sars.

fibres fixed to the circular coat and basement-tissue. In the middle line is the suspensory membrane of the alimentary canal. A massive almond-shaped lateral muscle then follows, the pointed end being inferior. This and the previous small median muscle of one side probably correspond to the single dorsal longitudinal muscle of other forms, unless it is to be supposed that the next and still more massive muscle is to be likewise

included in the great dorsal. Certainly no oblique muscle between the two latter appears as a proof of a contrary view. All the muscles are covered by a comparatively thick myolemma. Anteriorly there are two median ventral longitudinal muscles of a somewhat elongate shape, the narrow end being external, whilst the inner is curved on each side to form a hollow below the nerve-cords, which are ovoid in section and with a single neural canal. They lie in the area above the muscles and below the transverse band to which the mesentery from the alimentary canal is fixed. From each side of the nerve-cords at intervals a large nerve passes outward, and bending down between the central muscle and the adjoining, are certain of its fibres passing to the lateral region of the body as well as supplying twigs to the muscles themselves. Vertical muscular fibres from the ventral border also pass upward at the sides of the central muscle to the edges of the median dorsal muscles. The nerve-area lies freely on the summit of the muscle surrounded by a firm neurilemma. A single neural canal occurs in the middle superiorly, but it is much less than that found, for instance, in *Notomastus Grubei* of the 'Challenger.'

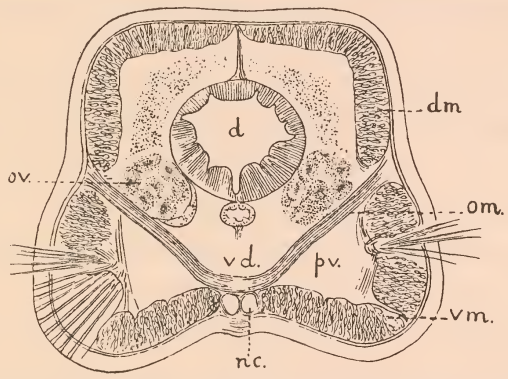

Fig. 130.—Transverse section of the anterior region of *Capitella capitata*. *ov.* Ova. *vd.* Accessory gut.

In transverse section the body-wall of *Capitella capitata* (Fig. 130) has under the cuticle a thick layer of hypoderm, which Fischer[1] calls the matrix of the cuticle, and the basement-tissue. Beneath is a well-developed circular layer of muscular fibres, which in the mid-ventral line passes external to the nerve-cords. The dorsal longitudinal muscles are separated only by the mesentery suspending the gut in the middle line, from which they extend as a continuous muscle on each side to the region of the oblique (called by Dr. Eisig the transverse). Their lower borders are thickest. The ventral longitudinal muscles, though somewhat shorter in total length, are more massive, but taper a little on each side of the nerve-cords to which they closely approach. The oblique muscles pass from each lateral region and are inserted over the nerve-cords, the circular muscular coat curving upward to form an arch immediately over the cords. These muscles are of considerable strength, and when contracted they cause the ventral region of the body to be grooved, a large rounded area projecting on each side. Fixed to the sheath of the oblique muscles in the female is the ovisac containing large ova. The ventral gut (Nebendarm) has thick muscular walls, and is closely adherent to the upper alimentary canal. The dorsal mesentery attaches the gut superiorly. The ciliated intestinal groove carries the water forward from the vent. The nerve-cords are distinct between the ganglia, and have only basement-tissue, hypoderm, and cuticle externally. A neural canal lies in the

[1] 'Anatomische-histol. Untersuch. von *Capitella capitata*,' Marburg, 1884, p. 12.

neuroglia between them. At the ganglia the cells of the neuroglia are increased and surround the sides and ventral curve of the large ganglionic area as a deeply stained chapelet. Moreover, the neural canal becomes indistinct. The perivisceral chamber is crowded with minute nucleated bodies—the blood-corpuscles which Ray Lankester[1] found to contain hæmoglobin.

Grube (1851) associated *Capitella* with the Oligochæta, placing it between *Clitellio* and *Nais*, the type being the *Lumbricus capitatus* of O. Fabricius.

The Capitellidæ were placed by De Quatrefages (1865) amongst the sedentary annelids between the Maldanidæ (his Clyméniens) and the Arenicolidæ, as a group of uncertain position. His three genera were *Capitella*, *Notomastus*, and *Dasybranchus*. This author's genera *Arenia* and *Ancistria* seem to be connected with the Capitellidæ, and it is possible that imperfections in description may be the cause of their separation.

Claparède (1873) observes that with regard to *Notomastus* and *Capitella*, the one has and the other has not the neural canals (his tubular fibres). He found these fibres in the Serpulids and Spionids, rudiments of them in the Terebellids and Cirratulids, but absent in the other families.

The Capitellidæ were associated by Levinsen (1883), after De Quatrefages, with the Maldanidæ under the Maldaniformia, yet this rested more on external aspect than on a full consideration of other features.

In (1884) Fischer[2] wrote his inaugural dissertation on the structure of *Capitella* and he gave an interesting but brief account of the various parts. He did not observe a neural canal, and the figure of the hook is abnormal.

Dr. Hugo Eisig published in 1887[3] a monumental work on the Capitellidæ of Naples, in which their structure, physiology, distribution, and systematic position were exhaustively treated in text and plates. He gives an historical account of the members of the family since Olafsen in 1774 described *Capitella capitata* or *Lumbricus littoralis minor* from Iceland. He divides the body into two regions, the thorax and the abdomen, and gives a minute description of the anatomy of each group, taking *Notomastus* as the type. In the body-wall of this genus, of which he has a diagrammatic transverse section,[4] he indicates the usual structure from without inward in the abdominal region, characterising the dorsal hooks as pertaining to the hæmal parapodium, and the ventral hooks as representing the neural parapodium. He terms the oblique muscles the transverse muscles, and has an upper and a lower alimentary canal. External to the hæmal parapodium is the ciliated abdominal side-organ on the surface, whilst in the lateral region is the parapodial branchial cavity. The alimentary canal is slung from the mid-dorsal region by a mesentery, and the lower division is fixed to the transverse mesentery over the nerve-cords. He deals with the alimentary canal under the heads of the proboscis, gullet, chief gut and accessory gut, the two latter lying in the abdominal region. Gregarinæ occurred in the canal. Under the nervous system he describes spinal nerves

[1] 'Proc. Roy. Soc.,' No. 142, 1873.

[2] 'Anat.-Histol. Untersuch. von *Capitella capitata*,' mit 2 Taf., Marburg, 1884.

[3] 'Monographie der Capitelliden des Golfes von Neapel,' pp. 906, 37 plates and 20 text-figures. Berlin, 1887.

[4] Op. cit., p. 17.

springing from the ganglia of the nerve-cords, and gives details of the structure of the eyes, which show cuticle, long cuticular cells (Hautfadenzelle), refractive cells, and nucleated fibres leading to ganglion cells. The ciliated organ lies in the groove between the cephalic and buccal segments, and is protruded as a rounded papilla from a sac on each side. The author next describes the ciliated side-organs[1] of the thorax and abdomen, pointing out their varying position in thorax, anterior, middle, and posterior regions of the abdomen. From without inward he shows sensory hairs beyond the cuticle, rod, granular spindle, nerve-fibril to hair retractors, nerve-fibrils to various ganglia intervening between the spindle and the spinal nerves. The cup-shaped (becherförmigen) organs of the head, proboscis, and the thorax are likewise sense-organs. The structure of the feet, segmental organs, reproductive apparatus, cœlom, and blood (hæmolymph) is likewise given.

The author then treats similarly, but more briefly, of *Dasybranchus*, *Mastobranchus*, *Heteromastus*, *Capitella*, and *Capitomastus*. He next contrasts the structure of the groups with that of other annelids, but though he cites *Polygordius*, *Sagitella*, the Oligochæts, Planarians, Cœlenterates, Echinoderms, *Peripatus*, the Myriapods, Molluscs, and Vertebrates, he does not mention the Nemerteans. A description of the various species occurring in the Neapolitan fauna is followed by a notice of those not included in it, whilst a comparison with other groups of Chætopods concludes the work which is an honour both in text and in plates to Naples and its Zoological Station.

Eisig[2] describes several nervous centres which Racovitza thinks are homologous with his middle and posterior regions of the brain.

Cuénot[3] (1891) maintained that in *Dasybranchus* and other forms the cœlomic corpuscles were formed in two red tubes which lie on the ventral surface between the intestine and the skin. He describes the tubes as having small septa and their walls covered with cells representing the cœlomic corpuscles in development. This observation is in need of confirmation.

The Capitelliformia constitute the fourth sub-order of Benham's[4] (1896) Nereidiformia (*more* Levinsen) which he places between the Amphictenidæ and the Opheliidæ. They appear to be more naturally placed between the Cirratulidæ and the Maldanidæ, as Malmgren formerly held.

Eisig[5] (1899) carried out an elaborate investigation on the development of this group from the period of fertilisation onward through the various quartettes of the micromeres to the division of the macromeres and the fate of the statoblasts, to the development of cilia on the larva and its escape as a trochophore, and thereafter its further growth to the third or fourth week. Every tissue was carefully investigated by this distinguished observer, and the various views with regard to cell-lineage were carefully weighed.

Gravier[6] (1901) describes a sub-genus of *Notomastus* (*Clistomastus*, Eisig) as occurring

[1] Except in *Capitella*, p. 494.
[2] 'Capitelliden,' p. 906, pl. xxxvii.
[3] 'Arch. Zool. expér.,' sér. 2, t. ix, p. 425, pl. xvi, fig. 13.
[4] *Op. cit.*, p. 331.
[5] 'Mitt. Zool. Stat. Neapel,' Bd. xiii, p. 1, pls. i—ix.
[6] 'Bull. Mus. Hist. Nat.,' Paris, t. viii, p. 402.

in fresh water and which he terms *Eisigella onanaryensis*. The anterior region (thorax) consists of twelve segments, and there are no branchiæ, no copulatory apparatus, and no genital pores. He[1] also notices a peculiar type of the family from the Red Sea, viz. *Scyphoproctus djiboutiensis*, in which the anterior region has fourteen segments, whilst the tail is expanded into a trumpet with two ventral cirri, the edge of the trumpet having groups of acicular bristles.

Nusbaum[2] (1905) was of opinion that in *Capitella* regeneration was as frequent as in the Spionidæ. Michel[3] (1901), on the other hand, kept the posterior regions of two examples for two and four months without any attempt at regeneration, so that it must take place slowly or under special conditions.

In this and other families of annelids Prof. Stephenson,[4] of Lahore, has carried out a series of investigations on the antiperistaltic movement of the gut posteriorly and its connection with intestinal respiration, and even nutrition.

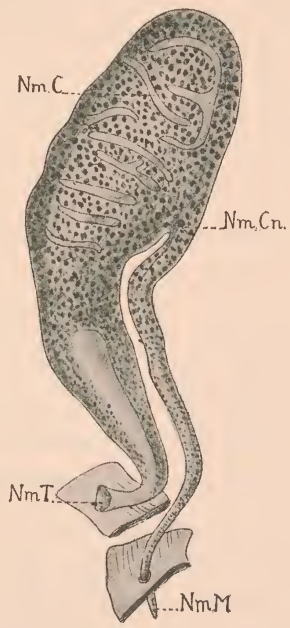

Fig. 131.—Nephridium of *Notomastus lineatus*, Clap., after Dr. Eisig. *NmC.* Nephridal canal. *NmCn.* Concretion. *NmT.* Funnel. *NmM.* Nephridiopore.

The segmental organs (Fig. 131) have true trumpet-like openings in the septa. The genital funnel in some forms (*e. g. Dasybranchus caducus*) is quite independent, acquires at maturity a pore to the exterior, and functions exclusively as a genital duct. In others the edge of the lip of the genital funnel may become connected with the septal trumpet of the segmental organ (*Dasybranchus gajolæ* and *Tremomastus*), but even in this case the funnel still develops an opening to the exterior for the genital products. In *Clistomastus*, where the products escape by rupture of the body-wall, the funnels are found only in a more or less rudimentary state, and do not normally open to the exterior (Goodrich,[5] who shows

[1] 'Bull. Mus. Hist. Nat.,' Paris, t. x, p. 557.
[2] 'Zeitschr. f. wiss. Zool.,' Bd. lxxix, Taf. xiii—xvi.
[3] 'Bull. sc. Fr. et Belg.,' t. xxxi.
[4] 'Trans. Roy. Soc. Edinb.,' vol. xlix, pp. 787, 802, etc.
[5] 'Quart. Journ. Micr. Sc.,' N.S., vol. xliii, p. 727.

sections of *Notomastus latericeus* in which the large genital funnels open to the exterior), and are quite independent of the segmental organs.

The *Capitellidæ* occur in sand or mud, in fissures of rocks, or in tubes amongst littoral algæ. Their food consists of minute organic fragments of various kinds in sandy mud, besides Foraminifera, Radiolaria, and Diatoms. The anterior region is often of a bright red as in *Notomastus*. One of the most remarkable is the genus *Scyphoproctus*, recently described by Gravier,[1] in which the posterior end terminates in a bristled scoop. Their distribution is cosmopolitan, the common forms and *Dasybranchus* frequenting the shore or shallow water, whilst some of the rarer forms range to 1340 fathoms in the collections of the 'Challenger.'

Pelagic larvæ appear in the tow-nets in July and are frequent in August, and at the end of October such have the form shown in Plate XCIII, fig. 10. This is a minute form, procured over a sandy bottom. The snout is pointed and rather conical, capable of being withdrawn within the ciliated collar behind. Eyes two, brownish-black. Body more or less cylindrical, slightly dilated in the middle, and again narrowed in front of the posterior ciliated ring, the pygidial region being bowl-shaped, with the wide margin in front. The alimentary canal shows a mouth but its lips do not project much. Within is an ovoid or slightly elliptical pharyngeal region ventrally, the large globules of the yolk passing dorsally above it. These globules are continued over the rest of the canal to the posterior end, and in the pygidium are deep purple by transmitted light, a paler tinge extending forward over the canal in the body. On each side is a close series of simple bristles. The foregoing larva resembles that described and figured by Claparède and Mecznikow as pertaining to *Capitella capitata*, except that their larva was yellowish. It also differs in coloration from that mentioned by Leschke, so that it may belong to another species, *e.g. Notomastus latericeus*.

Genus CXI.—Notomastus, *Sars*, 1851.

Capitella, Keferstein and Claparède; *Arenia*, De Quatrefages; *Sandanis*, Kinberg.

Capitellids, in which the anterior region is composed of twelve segments with two rings, and eleven bearing capillary bristles. Head bluntly conical, with or without eyes, with nerves from the anterior ganglia, and with ciliated nuchal organs between the head and the peristomium with nerves from the posterior ganglion (Eisig). Two pairs of cephalic ganglia. Peristomial segment broader than the succeeding. Anterior part of the body sub-cylindrical. Feet with two fasciculi of capillary bristles; no mamilla. The second region has its segments also two-ringed and furnished with ridges for hooks dorsally and ventrally. In the first eight to thirteen segments of this (posterior) region the two dorsal ridges of the foot coalesce into a single process in the dorsal median line. Branchiæ none: only simple lobes of the feet, either dorsal or ventral. Side organs from the first to the last bristle-bearing segment. Cup-organs occur on the proboscis, head, and anterior region. The œsophagus seldom has a diverticulum. The ventral nerve-cord is cœlomic, with a large neural canal. The segmental organs occur in each of the posterior segments. Reproductive products developed on the genital plate. The twelfth body-

[1] 'Nouv. Arch. Muséum,' Paris, 4e sér., t. viii, p. 181, pl. iii, figs. 200—204, 1906.

segment is sterile. Reproductive aperture generally on the last anterior or in the first posterior segment.

1. Notomastus latericeus, *Sars*, 1851. Plate XCII, fig. 2—part of body; Plate XCVIII, fig. 19—anterior region; Plate CVII, figs. 9—9 *b*—bristle and hook.

Specific Characters.—Head conico-acuminate, of two rings; at its base are two groups of brownish grains marking the nuchal organs. Body 6 to 8 in. long, more or less rounded dorsally, flattened ventrally, a little tapered in front of the large anterior region, then gradually diminishing to a tail with a slightly upturned vent and two papillæ beneath. Behind the larger anterior region of the buccal and eleven bristled segments the ventral surface is marked by a central band with a line at each side, but posteriorly this becomes less distinct, being merged in the ventral groove of that region. Anterior segments two-ringed and tessellated on the surface, whilst the posterior region has larger segments with prominent tori for the hooks. Each segment anteriorly has a double median dorsal elevation and two long lateral ridges which pass to the ventral surface. Posteriorly the four tori are more nearly equal and more widely separated, two being dorsal and two ventro-lateral. The median dorsal elevations have disappeared.

Colour of the anterior region deep reddish, behind which it is reddish-brown, and then greyish posteriorly. Sometimes blotched with pale lateral areas (yellowish-red, Grube, Carus), and with large white bodies in the cœlom. Anterior bristles with simple straight shafts, acute tips, and narrow wings. Hooks appear at the twelfth bristled segment on a double process in the mid-dorsal line, and they continue to the twentieth segment of the region. Thereafter both processes diminish, so that at the thirtieth no trace exists, only a dorsal and a ventral torus being present. The hooks are minute with an elongated shaft, a main fang above the slightly narrowed neck, and two spikes above it. Pore with palpocils, between the dorsal and ventral bristles of the first region; in the second region it occurs between the dorsal and ventral tori. On each side, a little behind the double median torus, in segments six to eleven, is situated the genital papilla.

Synonyms.

1851. *Notomastus latericeus*, Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 199.
1853. „ „ idem. Ibid., Bd. vii, p. 381.
1856. „ „ idem. Fauna Lit. Norveg., ii, p. 9, Tab. 2, figs. 8—17.
1861. „ „ Danielssen. Reise, 1857, Nyt Mag. f. Naturvid., xi, p. 54.
1862. ?*Capitella rubicunda*, Keferstein. Zeitschr. f. wiss. Zool., Bd. xii, p. 123, pl. xi, figs. 7—18.
1863. „ „ Claparède. Beobach. ü. Anat., p. 26, pl. xv, figs. 1—14.
1864. *Notomastus latericeus*, Grube. Insel Lussin, p. 86.
1865. *Arenia cruenta*, De Quatrefages. Annel., t. ii, p. 250, pl. xi, figs. 16—23.
„ *Notomastus latericeus*, idem. Ibid., Id., p. 258.
1867. ?*Saudanis rubicundus*, Kinberg. Öfvers. Vet.-Akad. Förh., Aar xxiii, 1866, p. 343.
„ *Notomastus latericeus*, Malmgren. Annul Polych., p. 97.
1869. ?*Capitella rubicunda*, Grube. Mitt. St. Vaast, Abh. Schles. Ges., 1868–69, p. 37.
1873. *Notomastus latericeus*, Sars. Bidrag Christ. Fauna, p. 74.
„ „ „ idem. Nyt Mag. f. Naturvid., Bd. xix, p. 274.
1875. „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, pp. 25 and 62.

1875. *Notomastus latericeus,* Panceri. Atti Soc. Ital., vol. xviii, p. 526.
1879. „ „ Tauber. Annul. Danica, p. 121.
„ „ „ Hansen. Nyt Mag. f. Naturvid., Bd. xxiv, p. 11.
„ „ „ Théel. Kongl. svenska Vet. Akad. Handl., Bd. xvi, p. 56.
1881–2. „ „ Horst. Niederl. Arch. f. Zool., suppl. Bd. i, No. 5, p. 20, pl. Annel., fig. 7.
1883. „ „ Levinsen. Vidensk. Meddel. Nat. For., p. 137.
1884. „ „ Langerhans. Zeitschr. f. wiss. Zool., Bd. xl., p. 259.
1885. „ „ Carus. Faunna Medit., p. 249.
1886. „ „ Levinsen. Kara-Havets Svampe, p. 10.
1887. „ „ Eisig. Die Capitell., p. 861.
„ „ *rubicundus,* idem. Ibid., p. 863.
„ „ *fertilis,* idem. Ibid., p. 819, pl. 1, fig. 1 (egg).
1888. „ *latericeus,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 681, pl. xlvii, fig. 44.
1894. „ „ De St. Joseph. Ann. Sc. nat., 8e sér., t. xvii, p. 117, pl. vi, figs. 152–157.
1896. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 331.
1897. „ „ Ehlers. Hamb. Magell. Saml., p. 117.
1898. „ „ Michaelsen. Polych. deutsch. Meere, p. 134.
1901. „ „ Ehlers. Polych. Magell. u. Chil., p. 188.
1904. „ „ Journ. M. B. A., vol. vii, p. 230.
„ „ *rubicundus,* Ibid., p. 230.
1906. „ *latericeus,* Bohm. Ann. Sc. nat., 9e sér., t. 3, p. 106 (movements).
1908. „ „ Ehlers. Deutsch. Tiefsee-Exped., pp. 10 and 130.
1909. „ „ Fauvel. Bull. Inst. Ocean., 142, p. 9.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 64.
1912. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. x, p. 124.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 130.

Habitat.—Tossed in numbers on the west sands, St. Andrews, after storms (E. M.); St. Magnus Bay, Shetland, eighty to one hundred fathoms (on a bottom of muddy sand) and in sixty fathoms nine miles off Balta (J. G. Jeffreys). On a muddy bottom in the West Voe of Scalloway in seven fathoms; three to four fathoms, Symbister Harbour, Whalsay (W. C. M.); Whitecliff Bay, Isle of Wight, and between tide-marks, Guernsey and Herm (A. M. and R. M.); twenty-five miles west of the Blasquet, South-west Ireland, in seventy-five fathoms (J. G. Jeffreys); Valencia, Berehaven, and South-west Ireland (R. I. A.); 'Knight Errant,' Station 3, fifty-three fathoms, August 3rd and 4th, 1880; Lochmaddy, north-west, between tide-marks (W. C. M.); Plymouth (Allen); west coast of Ireland (Southern).

Abroad it has been met with in Madeira (Langerhans); Bouvet Island and Magellan (Ehlers); in various localities off the shores of Norway (Sars and Canon Norman); six miles east of Cape de Gatte, in 60 to 160 fathoms; in the 'Porcupine' Expedition of 1870; Adriatic (Grube); Kara Havets (Levinsen); Greenland, Scandinavia, Finmark, and shores of the North Sea (Malmgren). Stretches to almost all European shores as well as to the Canary Islands, Madeira, Atlantic coast of North America, and Greenland. New England, U.S.A. (Verrill).

The *head* (Plate XCVIII, fig. 19) is conical and sharp pointed, of two rings, and it can be withdrawn so as to leave out the margin of the buccal segment in front. At its

base on each side are two groups of brownish grains (eyes ?) marking the nuchal organs. The second or buccal segment is biannulate, devoid of bristles, and the mouth opens on its ventral surface as a proportionally large aperture.

The *body* is from 6 to 10 in. in length, a little tapered in front of the large anterior region, remaining of nearly equal diameter for a considerable distance, and then tapering gradually to the tail, which ends in a slightly upturned vent with two papillæ beneath. It is more or less rounded throughout, dorsally, slightly flattened ventrally, and behind the rounded anterior region the latter surface is marked by a central band with a line at each side, though posteriorly it becomes less distinct, being merged in the ventral groove of that region.

The anterior region consists of the buccal and eleven bristled segments, each of which is two-ringed, and more or less tessellated on the surface. The succeeding region differs in appearance, having, as a rule, longer segments, with prominent tori for the hooks. Anteriorly each segment shows a double median dorsal elevation, and two long lateral ridges which pass to the ventral surface. Posteriorly again, the four tori are more nearly equal in size, and more widely separated, two being dorsal and two ventro-lateral in position, the two median elevations of the dorsum having disappeared, and toward the tip of the tail the four prominent tori give the body a quadrangular aspect on section.

Colour of the anterior region deep reddish, then reddish-brown and pale greyish posteriorly. Sometimes blotched with pale lateral areas (reproductive elements ?) and with large white bodies (cells) in the perivisceral cavity.

The anterior segments have a deep transverse furrow, which divides them into two halves. Laterally this furrow bends backward at each bristle-tuft, making, as it were, a small setigerous lobe or process, the bristles issuing quite at its posterior border. The two dorsal tufts are wholly dorsal and thus much nearer each other than the ventral. The bristles (Plate CVII, fig. 9) have simple straight shafts, which begin to taper at the slight bend marking the commencement of the somewhat narrow wing. Though the tip is acute, yet the whole bristle is elastic and strong. De St. Joseph states that their bases rest on a large gland.

At the twelfth bristled segment a double process carrying hooks appears in the mid-dorsal line, and this continues to the twentieth of the region without much change. Thereafter the two processes have a tendency to disappear, so that at the thirtieth no trace occurs, the arrangement resolving itself posteriorly into a dorsal and a ventral pair of tori, the former rounded and short, the latter more elongated. As a consequence a somewhat quadrangular aspect is given to this region of the body.

The medium dorsal tori and the dorsal and ventral tori, from the commencement of the second region of the body to the posterior end, are furnished with minute, elongated winged hooks of the same structure (Plate CVII, figs. 9 *a* and 9 *b*), viz. a long, slender shaft, slightly narrowed at its commencement, and again toward the neck, the tip ending in a small sharp, main fang, whilst the crown has two spikes above it. De St. Joseph states that there are from thirty-six to forty crotchets in the median dorsal series—some pointing to the right, others to the left, by which he means the double nature of the tori as already mentioned. Moreover, he describes and figures the spike next the great fang as having four points in a transverse row. There is certainly complexity.

Between the dorsal and the ventral bristles of the first region is a pore with palpocils, the opening of the lateral organ. In the second region the pore occupies the space which separates the ventral and dorsal tori (De St. Joseph). Further, a little behind the double median torus, is, on each side, in six to eleven of the first segments of second region, the papilla for the genital opening. In finely developed forms a distinct conical papilla is present at the inner dorsal edge of the great torus near the genital papilla.

The proboscis is extruded as a large button-shaped organ covered with minute papillæ. The stomach occupies the anterior region, whilst the intestine commences at the second region, and the gut is filled with muddy *débris*. The plasma is colourless, but the discs, which float in the cœlomic space, are reddish-brown, and are 0·010 mm. to 0·014 mm. in diameter (De St. Joseph).

The difference in tissue between the anterior and the succeeding region is sufficiently demonstrated by the condition of the large and fine examples tossed on the shores at the West Sands at St. Andrews, where almost every specimen consists only of this (anterior) region, with perhaps here and there traces of a few segments of the second region. The differences in the muscularity of the parts sufficiently explain this feature. Whether the result is due to abrasion during the storm or violence *in sitû* in the sand is an open question, but probably the former is the explanation, the less coherent posterior region disintegrating under the strain.

Reproduction.—In the first segment of the second region and in the six to eleven following are the openings for the issue of the genital elements on papillæ on the ventral surface. In some cases these are not visible, probably because the animal is unripe (De St. Joseph). Langerhans mentions that the ova are red or brownish-red. The whitish sperms give a dappled aspect to some males (Plate XCII, fig. 2).

A variety of this species (*Capitella D*) was dredged off Cape Finisterre at a depth of eighty-one fathoms in the 'Porcupine' Expedition of 1870. It (Plate XCVIII, fig. 21) is distinguished by its smaller size, but the bristles and hooks (Plate CVII, figs. 13 and 13 *b*) are similar.

Eisig established the genus *Tremomastus* from the presence of genital sacs in the second region. De St. Joseph doubts whether these are constant. Sars gives twenty pairs in *N. latericeus*, Horst eleven pairs, and De St. Joseph seven to twelve.

De St. Joseph found numerous Loxosomæ parasitic on an example. Those at St. Andrews are free from them. The experienced French author was of opinion that the *Capitella rubicunda* of Keferstein[1] is this species, and there is nothing in Keferstein's description and figures to contra-indicate this view except the absence of the median furrow in the anterior segments and the corresponding modification at the bases of the bristle-bundles. But in examples of *Notomastus rubicundus*, Keferstein, kindly sent from Plymouth by Dr. Allen, a distinct median furrow is visible, and though the specimens are all small, a similar arrangement of the bases of the bristles appears to be present, and also faint traces of reticulation of the surface, as indeed Keferstein's figure (fig. 7) indicates. It would therefore seem that this form is a variety (and in the Plymouth examples a young stage) of *Notomastus latericeus*. The hooks and bristles are identical, as are also the posterior segments and tail.

[1] 'Zeitschr. f. wiss. Zool.,' Bd. xii, p. 123, Taf. xi, figs. 7—18, 1862.

Notomastus D, ? variety of *N. latericeus*.

Dredged off Cape Finisterre in eighty-one fathoms in the 'Porcupine' Expedition, 1870.

A comparatively small form with an acutely-pointed snout of two segments, the terminal in some being almost probe-pointed. No trace of eyes occurs in the preparation. The body in all is incomplete, but it probably attains the length of *Capitella capitata*, and is about the same thickness. The peristomial segment has the proboscis in some thrust out as a flattened button, with a median depression. Its inner surface is covered with small, bluntly-conical papillæ. Twelve of the anterior (thoracic) segments have bristles dorsally and ventrally, each segment being two-ringed. Thereafter dorsal and ventral rows of hooks occur in the usual positions.

Genus CXII.—Capitella, *Blainville*, 1828.

Lumbricus, Olafsen; *Lumbriconais*, Œrsted; *Valla*, Johnston.

Capitellidæ with nine segments in the anterior region; segments one to six with capillary bristles and hooks, and the same in the eighth and ninth. The posterior region has only hooks. Head bluntly conical, snout inferiorly shovel-like. Protrusible ciliated nuchal organs close behind the eyes. Cephalic ganglia bilobed. Peristomial segment without bristles. Cup-shaped organs on the head, proboscis, anterior and posterior regions; side-organs absent. Body vermiform, elongate; anterior segments two-ringed and rounded; posterior segments flattened and about double the breath of the anterior. Branchiæ simple or branched on feet. Alimentary canal with œsophagus, stomach, and accessory gut opening in the last anterior and first posterior segment. Male genital opening single, dorsal, between eighth and ninth segments; female between seventh and eighth segments. Male with genital hooks or copulatory organs and glands. Sterile anterior ovary opens in fifth and sixth segments. Feet more or less retractile. Capillary bristles with winged hooks. Nerve-cords cœlomic anteriorly, hypodermic posteriorly. Provisional and permanent nephridia, the latter forming a double loop.

1. Capitella capitata, *O. Fabricius*, 1780. Plate XCII, fig. 3; Plate XCVIII, fig. 20—anterior region; Plate CVII, figs. 10, 10 *a*, 11 and 12—bristle and hooks (fig. 12 from a form with eyes).

Specific Characters.—Cephalic region with eyes, snout conical, sharp-pointed. Body about 5 in. in length, breadth 2 mm., generally less. Colour blood-red. Anterior region of nine or ten bristled segments, and at the twelfth about double the breadth. Capillary bristles and hooks on the seventh segment. First abdominal segment overlapping the anterior region a little. Abdominal hooks shorter. Cœlomic corpuscles yellowish-grey, with small, dark yellow excretory bodies. Alimentary canal generally with yellowish secretions (glands?). Genital sacs: a pair in the eighth anterior segment; genital pore incurved. Ovary in first posterior segment. Copulatory apparatus near dorsal division of the eighth or ninth segment, with genital hooks. Genital glands in the ninth segment. Reproductive period, November to May: eggs dark greyish-brown.

Synonyms.

1772. *Lumbricus litoralis minor,* Olafsen. Reise durch Island, p. 325.
1780. „ *capitatus,* O. Fabricius. Faun. Grönl., p. 279, no. 262.
1820. „ „ Savigny. Syst. des Annel., p. 94.
1827. „ *litoralis,* Johnston. Zool. Journ., vol. iii, p. 328.
1828. *Capitella Fabricii,* De Blainville. Dict. Sc. nat., t. lvii, p. 443.
1835. *Lumbricus capitatus,* Johnston. Loudon's Mag. Nat. Hist., vol. viii, p. 258, fig. 23.
1842. *Lumbriconais marina,* Œrsted. Kroyer's Naturh. Tidskr., iv, p. 132, Tab. 3, figs. 6, 11—12.
1847. „ *capitata,* Frey and Leuckart. Beiträge Wirbellosen Th., p. 151.
1849. *Lubriconais capitata,* Leuckart. Arch. f. Naturges., Bd. xv, p. 163.
1851. *Capitella Fabricii,* Grube. Fam. Annel., pp. 104, 146.
1857. „ *capitata,* Van Beneden. Bull. Acad. Roy. Belg., sér. 2, t. iii, p. 137, two plates.
1859. „ „ D'Udekem. Mém. Acad. Roy. Belg., t. xxxi, p. 25.
1861. „ „ Claparède. Mém. Soc. Phys. Hist. Nat. Genève, p. 110, Tab. i, figs. 9—15.
1862. „ „ Grube. Arch. f. Naturges., p. 366.
1865. *Valla ciliata,* Johnston. Cat. Worms Brit. Mus., p. 68.
„ *Capitella capitata,* De Quatrefages. Annel, t. ii, p. 255.
1867. „ „ Malmgren. Annul. Polych., p. 97, Taf. xvii, fig. 2.
1868. „ „ Claparède. Annél. Nap., p. 270, pl. xxvii, fig. 1.
1869. „ „ Claparède and Mecznikow, Zeitsch. f. wiss. Zool., Bd. xix, p. 191, Taf. xvii, fig. 2.
1874. „ „ McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875. „ „ Panceri. Atti. Soc. Ital., vol. xviii, p. 526.
„ „ „ idem. Invert and Fishes St. Andrews, p. 127.
„ „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 26.
1878. „ „ McIntosh. Trans. Linn. Soc. Zool., ser. 2, vol. i, p. 507.
1879. „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 56.
„ „ „ Tauber. Annul. Danica, p. 121.
1881. „ *prototypa capitata,* var., Czerniavsky. Bull. Moscow Soc. Nat., t. lvi, p. 340.
„ „ *intermedia,* idem. Ibid., p. 342.
„ „ *similis,* idem. Ibid., p. 346.
1883. „ *capitata,* Levinsen. Vidensk. Meddel. Nat. For., p. 137.
1884. „ „ Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxi, p. 260.
„ „ „ Webster and Benedict. Rep. Comm. F. and F., U.S.A., for 1881, p. 730.
1885. „ „ Carus. Fauna Medit., p. 248.
1888. „ „ Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 679, pl. xlvii.
1889. „ „ Michaelsen. Grönländ. Annel., p. 127.
1890. „ „ Malaquin. Annél. Boulonn., p. 46.
1891. „ „ Hornell. Trans. Biol. Soc. Liverpool, vol. v, p. 248.
1893. „ „ Lo Bianco. Atti R. Acad. Sc. Napoli, ser. 2, vol. v, no. 11, p. 19.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 111.
1897. „ „ Ehlers. Hamb. Magel. Samm., Lief ii, p. 117.
„ „ „ Michaelsen. Polych. deutsch. Meere, p. 133.
1901. „ „ Ehlers. Polych. Magell. u. Chil., p. 188.
1904. „ „ Journ. M. B. A., vol. vii, p. 230.
1908. „ „ Ehlers. Deutsch. Tiefsee-Exped., p. 130.
1909. „ „ Lo Bianco. Mitt. Zool. Stat. Neap., Bd. xix, p. 578.
1910. „ „ Southern. Proc. Roy. Irish Acad., vol. xxviii, p. 239.

1911. *Capitella capitata*, Fauvel. Bull. Inst. Oceanogr., no. 194, p. 28.
1912. ,, ,, McIntosh. Ann. Nat. Hist., ser. 8, vol. x, p. 126.
,, ,, ,, Gravier. 2e Exp. Antarct. Fr., p. 121.
1913. ,, ,, Ehlers. Deutsch. Südpol. Exped., p. 543.
,, ,, ,, Giard. Œuvres Div., p. 57.
1914. ,, ,, Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 130.

Habitat.—Seashore in wet gravelly places (Dr. Johnston); abundant under stones at the East Rocks, St. Andrews, and dredged in the Laminarian region in the Bay (E. McIntosh); between tide-marks in muddy sand, Clickamin, Lerwick; Guernsey and Herm, between tide-marks; Lochmaddy, North Uist (A. M., R. M., and W. C. M.); common in black mud in Wembury and Rum Bays, Plymouth (Spence Bate, Rowe, and Allen); Salthill, Co. Dublin (A. C. Haddon); Dublin and Clew Bays (Southern).

Cosmopolitan: Antarctic Sea, Magellan and Kerguelen (Ehlers); Madeira (Langerhans); Greenland (Fabricius, Michaelsen, and Ditlevsen); Iceland (Leuckart); shores of France (De Quatrefages, Fauvel, etc.); Mediterranean (Lo Bianco); Naples, in putrefying mud (Eisig).

European waters generally: Spitzbergen, Greenland, Scandinavia, Finmark (Malmgren), Black Sea, and, indeed, in all the seas of Europe. It stretches to the Atlantic coast of North America (Verrill, Webster and Benedict) and Madeira, and sometimes occurs in swarms, different generations cropping up in the same locality. It occurred at many stations in the 'Porcupine' expeditions, from the Atlantic to the Bay of Tunis.

Head (Plate XCII, fig. 3) an elongated cone with two minute lateral papillæ (the nuchal organs). The mouth opens as a puckered orifice on the ventral surface of the peristomial segment. The eyes are generally absent in spirit-preparations. A short clavate proboscis can be protruded.

Body about five inches in length, the swollen anterior region being about half an inch, increasing in breadth from the peristomial segment backward to the sixth or seventh and then slightly diminishing to the fourteenth, behind which the body is somewhat narrower, though this distinction is often obliterated. It diminishes posteriorly and ends in a knob-like or button-shaped process, often with a dimple in the centre, but reproduction of this region is so common that it is seldom a complete example is procured. The body is rounded anteriorly, and when preserved has a tendency to a quadrangular condition posteriorly, the ventral surface being flattened and generally grooved anteriorly, the groove in the larger examples being specially marked at the eighth, ninth, and tenth segments. On the lateral region of the body at the junction of the seventh bristled segment with that following is a vertically elongated papilla with a deep fissure in its centre apparently opening into the interior, whilst on the dorsum of the same specimen is a transverse line of genital bristles with a fissure in the middle line at the junction of this segment with the next (Fig. 132). On the ventral surface of the latter segment, the second behind the seventh bristled segment, is the depression at the end of the furrow leading into the aperture.

The body is deep red anteriorly, pale behind, but the colours vary according to the wave of the red cœlomic fluid, and the skin is iridescent anteriorly. Some show a peculiar piebald aspect posteriorly, dark grey and white being intermixed, the pale hue being due to large peritoneal bodies and ova.

The two genital segments, eighth and ninth (Fig. 132), have four bundles of strong spines —a pair to each segment. Just in front of the ninth segment are two opaque bodies (glands), one at each side. About the middle of the ninth segment and apparently immediately in front of the papilla is the anterior series of ten spines—five on each side, the outer being the smaller. They rapidly increase in size toward the middle line. The concavity of the curve of each spine, like the point of the hook at the tip, is directed outward and backward, the convexity looking toward the convexity of the adjoining series. A space occurs between them and the posterior pair, the points of which are directed forward, and just appear, under pressure, at the edge of the sexual aperture, which is ciliated. They are four in number, but the two inner are much larger than the outer, and they are directed

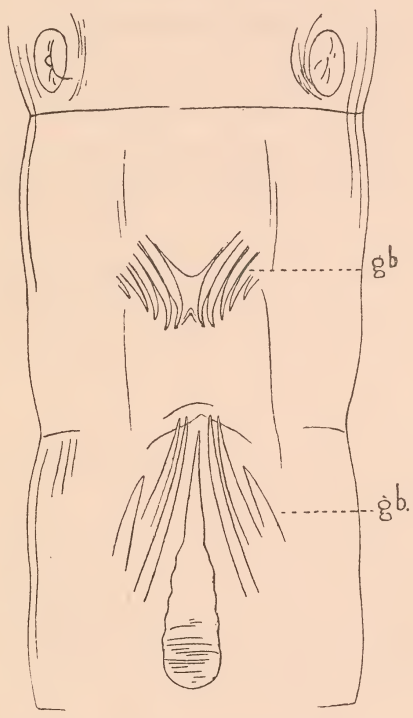

FIG. 132.—Modified bristles of the eighth and ninth segments of *Capitella capitata*, Fabr. *gb*. Genital bristles.

forward and inward, leaving a gap posteriorly between the pairs in which a pyriform glandular copulatory organ with an irregular margin lies, the duct running foward to the aperture.

The digestive tract is segmented by the diaphragms, and the posterior end is ciliated for some distance forward from the terminal anus. The corpusculated perivisceral fluid moves to and fro by the side of the gut with considerable force.

The anterior region (Plate XCVIII, fig. 20) following the peristomial segment consists of seven segments, each nearly symmetrically divided by four rows of golden bristles (Plate CVII, fig. 10). Each has two strong curves, and a double wing at the tip, as well as a slight shoulder below the upper curve to which the wing is attached. The same figure shows one of the tips, which are not very acutely pointed. In the line of the bristles a sub-annulus often appears.

In the ninth segment, hooks (Plate CVII, fig. 10 *a*) appear at the four points instead of bristles. Two of the dorsal hooks are nearer each other than the other pair.

The winged hooks have two minute spines above the main fang. The same arrangement is continued to the posterior end of the animal, though the caudal hooks are smaller.

Habits.—A constant series of contractions from behind forwards keeps the cœlomic fluid in active motion.

Reproduction.—Lo Bianco gives the reproductive period as from November to May at Naples.

J. P. Van Beneden[1] (1857) described the structure of this species, which he found inhabiting delicate tubes under stones between tide-marks. He figures the ripe male and female, the testes in the former occurring laterally in front of the genital hooks. The ovaries occupy a similar position in the female. The larva resembles that in Plate XCIII, fig. 10, and has two eyes and coarse globules (yolk) internally.

Dr. Johnston (1865) included *Capitella* under his Lumbricidæ, but his description shows that he refers to this form, which he found on the seashore in wet, gravelly places.

Claparède[2] (1863) describes the segmental organs in *C. rubicunda*, Keferstein, as pear-shaped, yellowish bodies, with an opening into the body-cavity and another on the dorsal surface between two lip-like papillæ, bearing palpocils. They are present in each body-segment.

The same author (1868) states that in the Hebrides he found examples with simple hooks whilst those from Naples had bifid hooks, the figure showing two spines above the great fang in lateral view. The eyes are present throughout adult life, though not always easily seen. In the young they are distinct and furnished with lenses. He notes that in the adult females at Naples the first six segments have four bundles of subulate bristles only; the seventh has its external bundles subulate, but the internal bundles have subulate bristles externally and crotchets internally. The eighth segment has only crotchets. In the male the first six segments have only subulate bristles; in the seventh segment the external bundle is composed of ten crotchets with perhaps a single subulate bristle inside, the crotchets outside. The eighth and ninth segments have only crotchets in the external series, the internal bundles being modified to form the copulatory apparatus. In the tenth segment the four bundles are formed exclusively of crotchets. It is interesting that in the young forms (after hatching) only three segments with simple bristles occur, and such is the condition for a considerable time. By-and-by, according to Claparède, bristles appear in the fourth segment in the place of the hooks. The sexual apertures of the female form transverse clefts on the ventral surface between the seventh and eighth segments, a little within the external fascicles of bristles.

Claparède and Mecznikow (1868) found the adults ripe during the winter at Naples. The youngest larva is elongate-ovoid with prototroch and telotroch, two eyes, and an alimentary region. The next stage has a conical snout and about a dozen body-segments, the buccal being the longest—with mouth and pharynx. The posterior region is bluntly-conical. When 1 mm. in length, the body is much more elongate, the snout and tail more pointed, the eyes have lenses, and sense-organs occur behind them. The pharynx occupies the buccal, the next, and part of the second bristled segments, then a narrow œsophagus leads to the stomachal region, behind which is the moniliform gut terminating

[1] 'Bull. Acad. Roy. de Sci. Belgique,' 26th year, 2nd sér., t. iii, p. 137, two plates.

[2] 'Beobacht. Anat. Entwickl.,' p. 27, pl. xv, figs. 5, 8, and 9.

in a rectum and anus with two papillæ. There are at least ten bristled segments. The cephalic ganglia are well developed, but no blood-vessel is visible. A few yellowish pigment-granules occur along the lateral region throughout the greater part of the body.

Cunningham and Ramage (1888) note that there are several segmental organs in each of the segments behind the genital opening. The ganglion of the ninth setigerous segment is continuous with the ventral epidermis. In front of that point both cord and ganglia are internal to the longitudinal ventral muscles, whereas behind it they are external to the circular muscles and in contact with the epidermis.

Michel[1] (1898) describes two buds, one short and one long, from the anterior end of a fragment.

Leschke[2] (1902) mentions a pelagic (telotroch) larva of *Capitella capitata* from the Bay of Kiel which somewhat approaches that from St. Andrews, and which had yolk-globules in the centre, and fourteen segments. He states that the pigment is greenish, whereas in the foregoing it was purplish.

Gravier (1912), in his finely illustrated treatise on the Polychæts of the Second French Expedition to the Antarctic, gives a table of the genera of this group. *Capitella*, which only has a copulatory apparatus in the male, has less than twelve anterior segments. Moreover, segments one to six have winged bristles, the seventh winged bristles and hooks, segments eight to nine hooks. The copulatory apparatus is included in the integument.

Genus CXIII.—Dasybranchus, *Grube*, 1846. Dasymallus, *Grube*.

Capitellidæ, in which the anterior region has fourteen bristled segments and the posterior region has dorsal and ventral rows of hooks. Head either small and bluntly conical, or relatively large and shovel-shaped. Eyes in specks or bands. Peristomial segment about as long as the next or a little longer. Proboscis with irregularly rounded or globular papillæ. Body long, cylindrical. Segments of anterior region two-ringed, the last two having the character of the posterior region. Segments of posterior region two-ringed and longer than those of the anterior. The ventral longitudinal muscle is less than in *Notomastus*. Ventral tori not so much dorsal in position as in *Notomastus*. Bristles relatively long; capillary in front. Hooks with two swellings of the shaft. Branchiæ on the posterior segments inferior, simple, or branched, retractile. Ciliated organ between the head and the peristomial segment (in relation to the cephalic ganglia). Lateral organs in all the bristle-bearing body-segments. Cup-organs in the proboscis, on the head, and the anterior region. Segmental organs begin on last anterior segment and continue throughout most of the posterior region. Ovary absent anteriorly. Genital apertures from the last anterior segment to the fortieth or sixtieth posteriorly.

This genus was founded by Grube, one of the veteran investigators of the group, in 1846,[3] under the title of *Dasymallus*, but this he afterwards (1851) changed to *Dasybranchus*. In his original description he thought it approached the Arenicolidæ, but

[1] 'Bull. sc. de Fr. et Belg.,' t. xxxi, 4e sér., p. 245.

[2] 'Wissensch. Meeresuntersuch.,' 5 Bd., p. 123, Taf. vi, figs. 11 and 12.

[3] 'Archiv für Naturges.,' p. 166, pl. v, figs. 3 and 4.

subsequent investigation showed that its real affinities were with the Capitellidæ. In the same author's 'Familien der Anneliden' (1851) he associated *Capitella* with the Oligochæta —placing it between *Clitello* and *Nais*, the type being *Lumbricus capitatus*, O. Fabricius. The extensive researches of Eisig have placed the genus on a modern footing.

1. Dasybranchus caducus, *Grube*, 1846. Plate CI, figs. 4 and 4*a*—head and branchial segments; Plate CVII, figs. 15 and 15*a*—bristle and hook.

Specific Characters.—Head relatively small, bluntly conical. Peristomial segment as long as the following. On each side twenty minute eyes. Body 1 metre long and breadth 1½ cm.; segments about 120; buccal segment achætous (Eisig). From fifteenth segment hooks dorsally and ventrally. Alimentary canal reddish-orange. Proboscis with tuberculated longitudinal ridges. Bristles from second to fourteenth segment. Segments anteriorly two-ringed. Segmental organs yellow or brown. Blood-red in front, yellowish-grey posteriorly, with red branchiæ; body externally dull brown, reticulated anteriorly. Yellow eggs deposited from February to August.

Synonyms.

1846. *Dasymallus caducus*, Grube. Archiv f. Naturges., Bd. xii, p. 166, Taf. v, figs. 3 and 4.
1851. *Dasybranchus caducus*, idem. Fam. Annel., p. 76.
1864. „ „ idem. Insel Lussin, p. 86.
„ „ „ Claparède. Glanures Zoot., p. 56, pl. viii, fig. 8.
1865. „ „ De Quatrefages. Annel. ii, p. 258.
1867. ? „ *cirratus*, Grube. Reise Novara, Annel., p. 28, pl. iii, fig. 4.
1868. „ *caducus*, Claparède. Annél. Nap., p. 281, pl. xxvii, fig. 5.
1875. „ „ Panceri. Atti Soc. Ital., vol. xviii, p. 526.
1878. „ *umbrinus*, Grube. Annul. Semper., Mém. Acad. St. Pétersb., xxv, p. 189.
„ „ *lumbricoides*, idem. Ibid., p. 190, pl. x, fig. 4.
1880. *Notomastus roseus*, Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 99, Taf. iv, fig. 11.
1885. *Dasybranchus caducus*, Carus. Fauna Medit., p. 249.
„ „ sp., McIntosh. Annel. 'Challenger,' pp. 10 and 390.
1887. „ *caducus*, Eisig. Monogr. Capitell., pp. 168, 823, pls. xvi—xxiii.
1891. „ „ Andrews. Proc. U.S. Nat. Mus., xiv, p. 293.
„ *Dasymallus* „ Cuénot. Arch. Zool. expér., 2e sér., ix, pp. 415, 425, pl. xvi, figs. 13—14.
1893. *Dasybranchus* „ Lo Bianco. Atti Accad. Sc. Napoli., ser. 2, vol. v, no. 11, p. 15.
1896. „ „ Benham. Camb. Nat. Hist., vol. ii, p. 331.
1898. „ „ De St. Joseph. Ann. Sc. nat., 8e sér., v, p. 387.
1902. „ „ Marenzeller. Denkschrift. Math.-Nat. Cl. K. Akad. Wiss., Wien, Bd. lxxiv, p. 21.
1904. „ „ McIntosh. Marine Invert. S. Africa, vol. iii, p. 70.
1906. „ „ De St. Joseph. Ann. Sc. nat., 9e ser., t. iii, p. 233.
1912. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. x, p. 127, pl. v, figs. 6—9.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870 at Station 8 on the Channel slope, at a depth of 257 fathoms.

It appears to be cosmopolitan in distribution. Mediterranean, Adriatic (Grube, Panceri, etc.); Bay of Tunis ('Porcupine,' 1870), Atlantic, Madeira (Langerhans). Large

examples in numbers in the fissures of rocks at St. Jean-de-Luz and other places on the shores of France (De St. Joseph); Naples in deep water (Lo Bianco); Cape of Good Hope (McIntosh).

A large form, some of the fragments being about 4 in. in length and 6 to 8 mm. in diameter. It is distinctly tapered anteriorly, gradually enlarges toward the middle and again probably tapers posteriorly, but as the specimen is incomplete this is conjectural.

The *head* (Plate CI, fig. 4) forms a short blunt cone which in the preparation is partly withdrawn into the peristomial segment, which is marked dorsally by a somewhat regular series of longitudinal striæ over an eminence. Ventrally the proboscis is protruded as a short cylinder with a corrugated and slightly glistening surface from tubercular or papillose longitudinal ridges. In the preparation the peristomial segment forms a blunt cone, and besides the eminence a differentiation of the longitudinal striæ a little in front of the middle dorsally and the presence of a transverse depression may indicate a sensory organ. Whilst this segment is undivided ventrally, a deep transverse furrow dorsally cuts off a posterior belt. Such may be an indication of the arrangement of the succeeding rings. The segment following the foregoing has the type of the thirteen which constitute the region, viz. is two-ringed, the middle sulcus having a broad papilla on each side dorsally directed backward, and bearing a tuft of bristles (Pl. CVII, fig. 15) which have a long, slightly curved shaft ending in a finely-tapered tip with wings. The symmetrical arrangement of the setigerous process is a feature it has in common with *Notomastus*.

The anterior region has a characteristic differentiation of the two rings of which the segments are composed, viz. in mid-dorsum is a straight line, bevelled, however, when it approaches the bristle-tufts, then laterally are two fillets, the upper being the smaller, whilst the long ventral line is bevelled at each side near the bristles. On the other hand the ring in front of that in the line of the bristles shows no special differentiation other than the setigerous processes posteriorly. The rings become proportionally narrower toward the termination of the region, at the fourteenth bristle tuft. The same arrangement of the fillets, however, occurs in the second ring for two or three segments, and then the fillets diminish to a single lateral papilla marking the separation of the dorsal rows of hooks from the ventral, the dorsal showing a lateral tumefaction on each side and a median depression in the preserved example, and the ventral a long lateral ridge separated from its neighbour only by the linear furrow over the nerve-cord. By-and-by a dark speck below the papilla probably indicates the aperture of the branchial organ.

In the posterior region the chief changes are the increase of the median dorsal space and the occurrence of a shorter interval between the now short tori and the lateral papilla. The tori indeed project dorso-laterally as isolated cushions. Ventrally, again, the median furrow separates two short tori, with the branchiæ at their outer borders, and the lateral papillæ have become more or less ventral. The space between the dorsal and ventral tori is longitudinally striated. The same arrangement continues to the tip of the tail, though the prominent features are toned down as the tail gently tapers, and the anus is dorsal.

The hooks occupy a ventro-lateral position not far removed from the dorsal arch, and thus in a ventral view they escape notice. They occupy a similar position with regard to

the median sulcus of the segment, viz. project on a flattened papilla or process behind it. Each hook (Plate CVII, fig. 15 *a*) has a slightly curved shaft tapered a little inferiorly, gradually enlarging to the commencement of the wing, then narrowing to the throat, from which the main fang comes off at a little more than a right angle, and with two teeth on the crown above. The wings are fairly broad, and are rounded distally beyond the fang.

Behind the last bristle-bundle a change in the segments is inaugurated, for whilst they remain two-ringed the dorsal papilla for the bristles disappears, and a lateral groove is gradually formed dorsally a little below the line of the bristles, this groove being rendered more distinct by a prominent papilla which marks the second ring of the segment laterally, and indicates the line of hooks below it. The mid-ventral line now presents a groove which continues for fully an inch backward. Instead of the bristles dorsally a line of hooks—indicated at first by a slight inflection of the median groove of the segment—takes their place. Ventrally a long band of hooks is present on each side, and by-and-by meet in the middle line, so that this region of the body is mainly concerned with movements in the tunnel in the mud or sand.

About the sixtieth armed segment the rows of hooks have arranged themselves on a long pad on each side dorsally, separated in the middle line by a considerable interval; whilst on the ventral surface the rows appear to meet in the middle line, so that a continuous series stretches from side to side, a slight inflection of the line in front and behind in the centre indicating the seat of separation in front.

Behind the foregoing region (sixtieth foot) the body in the preparation undergoes considerable dilatation dorsally, and the ventral line of hooks ends on each side laterally in a pale elevated ridge, which terminates abruptly superiorly, a pale striated region occurring between it and the commencement of the dorsal rows, which are still separated by a considerable interval. They are recognised by the opaque elevation in front and behind.

In the middle region the branchiæ have the aspect shown in Plate CI, fig. 4 *a*.

Moreover, in every segment in the posterior region an aperture exists about the upper end of the ventral row of hooks, and out of this a small branchia projects. Some are included until pressure is made on the body, and then they are distinct. These apertures are at a higher level, for instance, than those of the 'Challenger' form, Station 233 B, which are at each edge of the flattened ventral surface and have an elongated glandular fillet above them. The position of the branchiæ thus corresponds with the description and figure of Claparède from specimens procured at Port Vendres.

In the intestine of the middle region are many ovoid masses of mud as in *Chætopterus*. These consisted for the most part of very fine amorphous mud of a pale brown colour, with a few sand-particles, a few minute fragments of sponge-spicules, but very few traces of softer tissue.

The specimen appeared to be a female with small ova in the perivisceral cavity.

Reproduction.—At Naples, where it is termed "Vierme ca lana," the period of sexual maturity is from February to August.

Claparède (1864) found this species at Port Vendres, and gives an interesting account of its general structure, especially in regard to the branchiæ and pedicled lateral sacs.

The same author (1868) draws attention to the appearance of the mature male, in

which the perivisceral cavity is crowded with sperm-cells surrounded by a circle of smaller pale cells, so that the author compares them to floating testicles. The branchiæ are transparent, non-cilated, and contractile (though Claparède could see no muscular fibres), and have areolated hypoderm.

De St. Joseph[1] describes *Notomastus exsertilis* from St. Jean-de-Luz, a large species about 8 mm. in diameter and 800 mm. long, as possessing exsertile branchiæ (about 20) similar to those of *Dasybranchus*, to which genus it may probably be relegated.

In an example from Concarneau, De St. Joseph found the branchiæ covered with *Rhabdostyla arenicolæ*, Fabre Domergue.

Dasybranchus is the giant of the family, for Eisig and Lo Bianco found examples at Naples about a yard in length and more than half an inch in diameter.

A fragment of the middle region of what appears to be a *Dasybranchus* was dredged in the 'Porcupine' Expedition of 1870, off Cape Sagres, in forty-five fathoms. The hooks agree with those of *D. caducus*.

Dasybranchus, fragment.

Dredged in the 'Porcupine' Expedition of 1870 at Station 8, on the Channel slope, 257 fathoms.

This form is represented by a fragment of the posterior end with a small median anus surrounded by a papillary margin, the two largest papillæ being ventral. The body is slightly flattened ventrally, rounded dorsally, and with distinct segments. Moreover, along each side dorsally is a row of simple branchiæ, one or two in each segment. They are absent from the anterior part of the fragment, and cease before reaching the anus.

Dasybranchus (?).

Fragments of the anterior and middle region of a form which appears to be near *Dasybranchus* (*?*) were dredged in 80 to 100 fathoms on muddy sand in St. Magnus Bay, Shetland, by Dr. Gwyn Jeffreys in 1867. Certain differences, however, are apparent.

In what seems to be a portion of the anterior third the ventral ridges for the hooks extend round the edges of the flattened body to the dorsal surface, where they cease. No hooks could be found dorsally, that is, no special dorsal ridges for hooks are present, and thus it differs from *Dasybranchus*.

The dorsal surface is rounded and lobed, and the walls are thin, so that in the fragments of the middle (?) the muddy contents and reddish-orange hue of the gut shine through the wall.

The ventral surface is thick and flattened in front, with a median ridge, which, however, is absent from the posterior fragments. These are only ridged transversely by the row of hooks, which are minute, have a very short main fang, two teeth above it, and conspicuous wings. The ventral longitudinal muscles are greatly developed. The intestine is filled with greyish muddy sand.

[1] 'Ann. Sc. nat.,' 9e sér., t. iii, p. 169, pl. ii, figs. 44–47, 1906.

Family XXIV.—Maldanidæ, *Malmgren.*

Maldanies (Savigny, 1820); Maldanies (Blainville, Grube); Clyméniens (Milne Edwards, De Quatrefages).

Cephalic lobe (prostomium) generally connate, the buccal segment (peristomium) often with a cuniform dorsal lamina, but nude or achætous. A median keel, on each side of which is a nuchal organ. Proboscis well developed. Body rounded, smooth, of several regions, anterior, middle, and posterior, scarcely or slightly tapered posteriorly; segments long, few (twenty-six or twenty-seven). It terminates posteriorly, either as a naked process, or is provided with a funnel, or a plate similar to the anterior region, or the

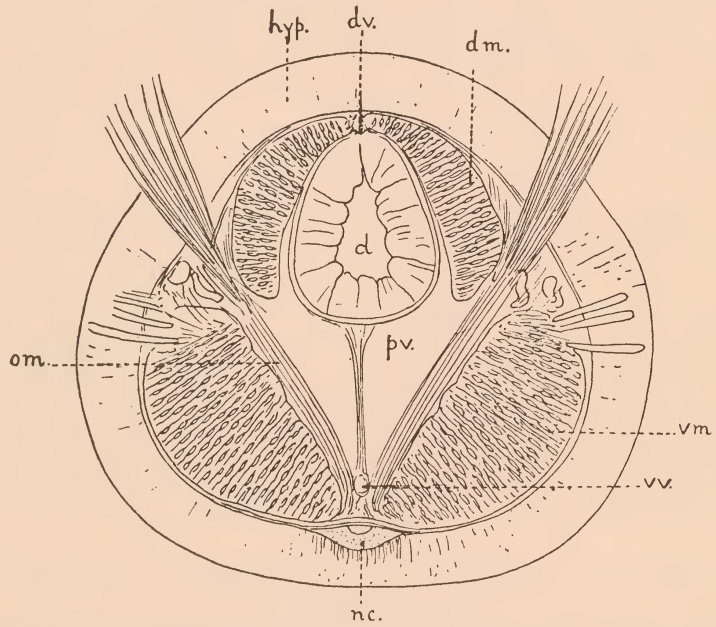

Fig. 133.—Transverse section of the anterior region of *Nicomache maculata,* Arwidsson.

funnel has cirri and a simple or foliaceous plate with a central anus, or a plate with a sub-dorsal anus. Ante-anal segments often achætous. Alimentary canal straight. The nephridia open near the ventral rows of hooks. The cutaneous glands are largely developed. Feet in anterior segments at the anterior part of segment, in the posterior region at the posterior border of the segment, biramous. Dorsal capillary bristles, which may be winged, pinnate, or spinous. No uncinigerous tori in the anterior region. Circular hooks or crotchets in one or two rows, situated at the front, middle, or posterior part of the segment. Tube either having adherent mud or pebbles throughout, or composed of mud.

The body-wall in *Nicomache maculata* (Fig. 133) has a thick layer of hypoderm under a thin cuticle, the underlying basement-tissue resting on a thin but firm circular muscular coat, which passes to the inner side of the nerve-trunks, at which it is joined by the oblique muscles. These, however, are nearly vertical in position, since the dorsal muscles are of limited extent, and they leave the basement-tissue and circular coat to the outer side of the smaller division of the dorsal longitudinal muscles, and pass to the circular coat

and neurilemma on each side of the middle line above the nerve area. The foot is pushed far upward, and thus these bristles are at the dorsal attachment of the oblique. The dorsal longitudinal muscles are separated by the dorsal blood-vessel, the mesentery from which is fixed to the upper arch of the alimentary canal. They form a lobate area with the broad end downward on each side of the alimentary canal, whilst a separate slip, triangular in section, lies between its upper border and the origin of the oblique. The ventral longitudinal muscles are of great proportional bulk, and stretch from the nerve-cords to the dorsal origin of the oblique muscles, a narrow fasciculus, however, filling the gap at the lateral blood-vessel. The alimentary canal has external circular and longitudinal muscles, and a thick glandular mucous lining thrown into numerous folds. Beneath is the ventral blood-vessel. The nerve-area is hypodermic, of ovoid or slightly spindle-shaped outline, and with a large neural canal in the middle line superiorly. Externally is a considerable sheath of neuroglia, the cells of which stain more deeply than the hypoderm. Between the attachments of the oblique muscles is the ventral blood-vessel.

In *Praxillella prætermissa* the hypoderm, which has externally a thin cuticle, is as largely developed as in *Nicomache*, and inside the basement-membrane is a well-marked circular coat. The dorsal longitudinal muscles have somewhat increased in size and each is contiguous, in transverse section, to the dorsal origin of the oblique. The ventral longitudinal are long and clavate, the larger end in section being ventral, thus forming a bulky mass over the outer end of the nerve-cord on each side of the attachment of the oblique. The nerve-area is ovoid or flattened, with a large median neural canal superiorly. Interiorly is the circular muscle, externally only the hypoderm and cuticle.

The body-wall in *Praxillella gracilis* has a similar hypoderm and cuticle to the foregoing, but in proportion to the ventral the dorsal longitudinal muscles have somewhat increased in size, whilst the bulky ventral longitudinal almost touch in the mid-ventral line. The nerve-area holds the same position, is somewhat less flattened, and has many deeply-stained cells of the neuroglia around it. Moreover, no neural canal is visible. The ovarian sac on each side of the alimentary canal is distended with large ova.

In transverse sections of *Maldane Sarsi*, var. of the 'Challenger' Expedition, the quadrate nerve-cords have moved inward and lie between the inner ends of the somewhat extended ventral longitudinal muscles, the thin circular fibres bending inward with them, whilst the oblique are attached to the upper and outer angle, and there is no neural canal. In this example the sperms occupy the general cœlom.

O. F. Müller's[1] (1788) *Lumbricus tubicola* is evidently a Maldanid, but there is nothing definite in either figure or description to diagnose the species.

On Plate CIV the same author figures a Maldanid in a tube—possibly a broken *Axiothea* or *Praxillella*. He calls it *Lumbricus sabellaris*.[2] It is truncated at either extremity, the anterior segments are shorter, especially the first four. Posteriorly are seventeen or eighteen longer segments. He observes that one end has a denticulated funnel, whilst the other is attenuate and truncate. It somewhat resembles *Nicomache*.

The Maldanies of De Blainville formed the first family of his Paromocriciens, the second being Telethusæ. These were supposed to have a thoracic and abdominal region. His

[1] 'Zool. Danica,' vol. ii, p. 49, Tab. lxxv.

[2] Ibid., iii, p. 37.

Clymene amphistoma may be an *Isocirrus*, with notched cephalic rim and uniform anal cirri. *Tubifex marinus*,[1] again, which he figures from O. F. Müller (De Blainville's, Plate 35, fig. 2), resembles *Nicomache*.

The group now under consideration formed the Clyméniens and Maldanies of Savigny, and the Clyméniens of Milne Edwards and De Quatrefages. Cuvier placed them (Clymenea) under the abranchiate setigerous division along with *Nais*.

The brain in *Clymene truncata* is described by De Quatrefages[2] as small, bilobed, and with two nerves in front. The œsophageal connectives are slender at first, but increase posteriorly, and they give many small branches to the muscles. The visceral system is, he thinks, represented by minute twigs from the anterior part of the connectives. The ventral chain resembles that of the Cirratulids. Externally is a coat of parallel fibres. The ganglia show neither connectives nor commissure, though they are numerous, each foot having a pair touching in the median line, whilst a band of very small ganglia, apparently isolated, occupy the rest of the segment and give twigs to the muscles.

Grube's Maldania (1851) had but a single genus, *Clymene*, with six species, but he also included *Ammochares* (*Owenia*) under the same family. In his original description of the genus *Maldane*[3] he noted the structure of the cephalic region and the absence of an infundibulum posteriorly.

In his 'Invertebrate Animals of Vineyard Sound' Verrill describes new species of *Nicomache*, *Rhodine*, and *Maldane*, but the minute distinctions of these from the European forms appear to require further investigation.

Two species of *Clymene* are entered in Dr. Johnston's 'Catalogue of the Non-Parasitical Worms' (1865), viz. *Clymene borealis*, Dalyell, and *Clymene lumbricalis*, Audouin and Edwards. As Dr. Johnston, however, correctly states, Sir John Dalyell described the caudal funnel as the head and the cephalic plate as the tail, and thought that in all probability it was the *Sabella lumbricalis* of Fabricius, a form entered in the Appendix to the Catalogue, and synonymous with *Nicomache lumbricalis* (*Nicomache maculata* in Britain).

The position assigned to this group by De Quatrefages (1865) was peculiar, the family being placed after the Tomoptériens, which he also regarded as sedentary annelids. In his table six genera are at once separated from the others by the fact that their bodies are divided into three regions. These are further subdivided by the presence of an anal funnel, by the presence of an anal plate, or by the absence of both. Under the first head two genera are isolated as having no respiratory cæca, *Clymene* being further distinguished by having a large cephalic plate, whilst *Léiocephale* has none, or only a rudimentary one. The third genus of this series, viz. *Johnstonia*, has respiratory cæca. Two genera have an anal plate, viz. *Maldane* and *Petaloproctus*, the former being separated by the presence of a cephalic plate, which is absent in the latter. His sixth genus, *Ammochares*, which has neither plate nor funnel, belongs to another family. His next series of four genera is characterised by the division of the body into two regions only, the first genus, *Clymenide*, having a truncate head, the other three not showing this structure; the snout, indeed, in

[1] 'Zool. Danica,' vol. iii, p. 497.

[2] Annel. ii, p. 367.

[3] 'Arch. f. Naturges.,' Bd. xxvi, p. 92.

Arenia and *Ancistria* being pointed, the former possessing simple bristles, the latter bearing only crotchets in the posterior region. *Clymenia*, the last genus, has a massive snout. The relationship of several of the last group of genera with the Maldanidæ is doubtful.

M. Sars[1] (1868) found *Asychis biceps* at 200 fathoms, *Maldane pellucida* and *Praxillella prætermissa* at 300 fathoms.

Grube[2] (1868) arranged the Maldanidæ thus:

1. The terminal segment infundibuliform, with the anus in the middle.

(*a*) The rim of the anal funnel is produced into cirri or processes. Under this head the species are distinguished by the number of the bristle-bearing segments.

(*b*) The rim of the anal funnel is smooth.

2. The terminal segment is devoid of a funnel. Grube included *Owenia* under this head, but it is now more appropriately placed in a separate family, as he himself did in the 'Philippine Annelids.'

The characters of the family Maldaniæ, Savigny, were revised by the same author in his 'Philippine Annelids' (1878).

Grube (1869) in his further critical remarks on the Maldinidæ classifies them thus:

1. Terminal segment funnel-shaped, the anus in the middle of the cup.

a. All with notches or teeth on the funnel—*Rhodine*, *Nicomache*, *Axiothea*, *Praxilla*, *Clymene*. Under this head the author diagnoses the following:

Clymene zostericola, with sixteen bristled segments. With seventeen bristled segments—*Axiothea catenata*, Malmgren (four ante-anal segments present), *Clymene modesta*, De Quatrefages, and *C. lyrocephala*, Schmarda. With eighteen bristle-bearing segments—*C. uranthus*, Savigny (Savigny gives nineteen and four ante-anal segments). With nineteen bristle-bearing segments and five ante-anal—*Praxilla prætermissa*, Malmgren, *P. arctica*, Malmgren, *P. Kefersteini*, Kinberg, *Clymene gracilis*, Sars, *C. Muelleri*, Sars. Under this section fall such as have only three ante-anal segments, *e. g. C. lumbricoides*, Milne Edwards (De Quatrefages gives only fifteen or sixteen segments), *C. diadema*, Grube, and those with two ante-anal segments, *C. digitata*, Grube, and *C. Œrstedi*, Claparède. With twenty-two bristled segments and two ante-anal—*C. palermitana*, Grube. With twenty-three bristled segments and three ante-anal—*C. amphistoma*, Savigny.

b. Clymenidæ with a smooth saucer or funnel without teeth—*C. urceolata*, Leidy, and *C. leiopygos*, Grube.

2. The terminal segment without a funnel, the anus opening dorsally—*Chrysothermis* and *Sabaco*, Kinberg, *Maldane*, Grube, and *Petaloproctus*, De Quatrefages.

Cosmovici (1880) found in *Clymenia zostericola* at Roscoff four pairs of organs of Bojanus situated in segments four to seven. They are, to judge from the figure, botryoidal structures placed behind the segmental organs, and are highly vascular, cells and granules with a lining of ciliated epithelium composing their structure. The four pairs of segmental organs lie in front of the organs of Bojanus and consist of short bodies with a large funnel. He describes the genital glands as attached near the organ of Bojanus.

[1] 'Vidensk.-Selsk. Forhandl.,' 1868, (sep. copy) p. 10.

[2] 'Abh. Schles. Gesellsch.,' Breslau, pp. 47—49.

Levinsen (1883) grouped the Maldanidæ along with the Capitellidæ under his Maldaniformia, an association, perhaps, that is open to criticism, for there is comparatively little in common between them. The order in which he places the genera is: *Rhodine*, *Lumbriclymene*, *Nicomache*, *Nicomachella*, *Clymene*, and *Maldane*.

The Maldanidæ were included by Benham (1896) under the Scoleciformia, the fifth sub-order of the Nereidiformia, along with the Opheliidæ, Arenicolidæ, Scalibregmidæ, Chloræmidæ, and Stenaspidæ—a varied series.

Neural canals occur in *Nicomache maculata* and in "*Axiothea catenata*" according to Cunningham (1888).

In 1894 De St. Joseph gave a classification of the Maldanidæ founded on the external structure of the head and anal funnel, together with that of the bristles and hooks.

1. Head with cephalic plate more or less smooth, more or less inclined in rear, and surrounded by a thickened margin or not. Uncinigerous segments with a transverse row of crotchets with sub-rostral barbules.

A. Anal segment having a ciliated funnel with cirri on the edge, the anus being in the centre.

a. Ventral capillary bristles replaced by crotchets in a certain number of the anterior segments.

a^1. External vascular cæca in parallel rows in most of the posterior segments. *Johnstonia*, De Quatrefages.

a^2. No external vascular cæca. *Clymene*, Savigny (including *Praxillella*[1] = *Praxilla*, Malmgren, and *Neco*, Kinberg).

b. Ventral hooks (crotchets) in all the setigerous segments. *Axiothea*, Malmgren (including *Clymenella*, Verrill).

c. No ventral bristles (aciculaires) or crotchets in the first segment. *Maldanella*, McIntosh.

B. Anal segment forming a smooth plate without cirri, the anus being under the plate. No acicular bristles or crotchets in the first setigerous segment. *Maldane*, Grube, Malmgren, *char. emend.*

C. Anal segment two-ringed, cleft laterally, without plate or funnel; anus dorsal. *Chrysothemis*, Kinberg (including *Sabaco*, Kinberg).

2. Head without a bordered plate.

A. Ventral hooks (crotchets) without sub-rostral barbels and with two transverse parallel rows of hooks in a certain number of the segments.

Anal segment without plate or funnel, and with the anus sub-dorsal. Devoid of hooks or capillary bristles in a certain number of the anterior segments. *Rhodine*, Malmgren, Ehlers, *char. emend.*

B. A simple row of ventral hooks with sub-rostral barbels in the uncinigerous segments.

1. Capillary bristles in a certain number of the anterior segments.

a. Anal segment with a ciliated funnel and the anus in the centre. *Nicomache*, Malmgren (*Leiocephalus*, De Quatrefages).

[1] This name was proposed by Verrill in 1882, as *Praxilla* had been used by Reichenbach in 1853, for a genus of birds. 'Trans. Conn. Acad.,' vol. iv, p. 298.

b. Anal segment patelliform without cirri, the anus on a cone in the centre. *Leiochone*, Grube.

c. Anal segment with a concave foliaceous plate without cirri. Anus opens on its surface. *Petaloproctus*, De Quatrefages. (*Nichomachella*, Levinsen.)

d. Anal segment obliquely truncated with neither plate nor funnel; anus sub-dorsal. *Lumbriclymene*, Sars. (*Praxillura* Verrill ?).

2. Ventral crotchets on all the setigerous segments. *Paraxiothea*, Webster.

Racovitza[1] (1895) criticises the opinion of De Quatrefages[2] that the cephalic lobe is reduced to a minute mass comparable to that in *Arenicola*, only soldered to the buccal lobe. The brain is small, bilobed, and gives off posteriorly two minute twigs (nuchal nerves, Racovitza), which with five or six other connectives to the proboscis probably represent the stomato-gastric system. Semper,[3] again, describes supra-œsophageal ganglia and the connectives united with the epidermis from which they are little separated. Ehlers holds that the cephalic lobe is formed of the cephalic plate, which is always soldered to the first segment. The views of De St. Joseph were similar.

Racovitza groups the Maldanidæ under three heads or types: (1) The cephalic lobe has a palpode: ex. *Leiocephalus leiopygos*, Grube. (2) The cephalic lobe has a palpode and a cephalic plate, *Clymene lumbricoides*, Milne Edwards. (3) The cephalic lobe has neither palpode nor dorsal cephalic plate: ex. *Petaloproctus spatulatus*, Grube. The cephalic ganglia are small, situated behind the palpode, when present, and give off the œsophageal connectives which are superficial, and a nuchal nerve on each side. He thinks that the primitive nerve-cell was bi-polar—one end superficial and the other basal.

Orlandi (1898) describes the segmental organs in *Clymene palermitana*, Grube, as somewhat clavate in outline with a funnel-shaped nephrostome communicating with a wide tube which gradually diminishes to the nephridiopore. He[4] (1898) gave a description of the Maldanids of Naples, prefacing his account with general remarks and the classification of De St. Joseph. Besides four known species, he describes three new forms under the genus *Clymene*, the only one he mentions. Thereafter he gives a brief account of the structure of the dermal tissues, the muscles, nervous system, alimentary canal, vascular system, segmental and reproductive organs.

The same author[5] (1903) has described the reproduction of the anterior and posterior regions in several forms such as *Clymene collaris*, Claparède, and other species at Naples.

In an interesting paper on the nervous system of two species of this family, viz., *Axiothea torquata*, and *Clymene producta*, Miss Lewis[6] (1898) gives details of the giant nerve-cells and Leydig's fibres (neural canals or giant-fibres). The presence of a centrosome and sphere is mentioned in the giant-cells, and also the eccentric position of the nucleus. The sense-organs of the skin are also minutely described.

One of the most recent as well as one of the most important classifications is that of

[1] 'Arch. Zool. exper.,' sér. iii, vol. iv, p. 227 *et seq.*

[2] 'Hist. Nat. Annél., t. ii, pp. 229—293.

[3] 'Arch. Zool. zoot. Instit. Würzburg,' Bd. iii, p. 147.

[4] 'Atti Soc. Ligust. Sci. Nat. e Geogr. Genova,' vol. ix, p. 1, Tav. v—viii.

[5] Ibid., vol. xiv, 1903.

[6] 'Proc. Amer. Acad. Arts and Sc.,' vol. xxxiii, p. 225, pls. 1—8.

Arwidsson[1] (1907) in which he uses the general form of the body, head-plate, nuchal organs, bristles and rows of hooks, the presence of spines anteriorly, the nature of the collar, the arrangement of the glands, and other features to separate the species. The arrangement of this author has, as a rule, been followed, though the sub-families have been thought unnecessary in the present case.

Arwidsson (1907) also gave an account with good figures of the epiderm, including in the term the hypoderm of a Maldanid.

An interesting memoir with two plates on Maldanids of the North and East Seas by Dr. William Nolte[2] has recently appeared. The author gives an historical account of the family from O. F. Müller's period (1788) to Arwidsson's, indicates the material procured by the 'Poseidon,' and treats it faunistically and anatomically. He describes eleven species, all known forms.

The Maldanidæ, as a rule, haunt the fissures of rocks, or the littoral region at low water, where their tubes may form a miniature forest. Others live on a muddy bottom, amidst Foraminiferous and Radiolarian deposits, and may be found at a depth of 2300 fathoms as in the 'Challenger.' They are cosmopolitan in distribution. Their colours are usually bright, and bands of red and white, or brown are common.

The representatives of the Maldanidæ are met with but seldom in British waters, and in the majority of instances only fragments are secured, often of the middle of the body, sometimes of the head or the caudal funnel. Thus the task of identifying the species requires an expenditure of time which is not always commensurate with the results; and even after considerable attention to the family a feeling remains that much more yet requires to be done for their complete elucidation. A basis for future faunistic researches, however, has been sketched.

Young Arenicolids have sometimes been mistaken for other forms, and supposed to be intermediate types between the Arenicolidæ and Maldanidæ.[3] The genus *Clymenides*, for example, consists only of young Arenicolids. *Branchiomaldane vincenti*, supposed by Fauvel and others to be in the same category, is, however, as shown by Langerhans and Ashworth, an adult, hermaphrodite form.

Besides the parasitic forms mentioned in connection with the several species, two are recorded on other examples of the family not specifically identified, viz. a Trematode —*Cyclatella annelidicola*, as described by Van Beneden and Hesse,[4] which, however, M. Prouho[5] states to be a *Loxosoma*, and a Copepod, *Hersilionides Pelseneeri* (*Antheria latericia*, Grube) reported by McCann[6] as a commensal in the tube of *Clymene lumbricoides*, De Quatrefages.

Several species found by De Quatrefages and De St. Joseph on the shores of France, and the descriptions and figures of which do not lead to certainty, may yet occur on the British shores, or are identical with those found there. Amongst these are *Clymene lumbricoides*, De Quatrefages, and *Petaloproctus terricola*, De Quatrefages.

[1] 'Zool. Jahrb.,' Suppl. ix, Heft 1, p. 4.

[2] 'Jahr. Wissenschaft. Meeresuntersuch.' N F., Bd. xv, pp. 1—91, Taf. i and ii, 1913.

[3] Cf. Mesnil, 'Bull. Sc. France et Belg.,' t. xxx, p. 144, pl. vi, and idem, ibid., t. xxxii, p. 317.

[4] 'Recherches sur les Bdellodes et Trematodes Marins Bruxelles,' p. 82, pl. vii, figs. 12—13.

[5] 'Compt. Rend. Acad. Sc.,' Paris, t. cxi, p. 799, 1890.

[6] 'Bull. sc. France et Belg.,' t. xix, p. 421, 1888.

Genus CXIV.—Lumbriclymene, *Sars*, 1872.

Head-plate absent. The nuchal organ makes a wide curve. The anterior segments more or less elongated; posterior end of the body diminished with a sub-dorsal anus. Nephridia in several segments. Glandular belts on the anterior segments, several of which have spines. The hooks have gular bristles. Tube straight and free.

1. Lumbriclymene minor, *Arwidsson*, 1906. Plate CVIII, fig. 1—hook.

Specific Characters.—The anterior end of the body with yellowish rings at the feet from the first to the eighth bristled segment, that of the fourth generally of a citron-yellow hue. The feet of the three anterior long-bristled segments near the anterior border, whilst those after the eighth are behind the middle of the segment. The fourth and the seventh bristled segments have a long, smooth region behind the anterior border. Eighteen (?) bristled segments. Segments five to eight with specially developed glandular bands anteriorly. Small spines on first four anterior segments, one (or two) in each. The fifth segment has hooks. Teeth of the hooks six to seven. The anterior bristles with short wings, others with long, slender, tapering points with narrow wings.

Synonyms.

1906. *Lumbriclymene minor,* Arwidsson. Skand. u. arktisch. Maldan., p. 46, Taf. i, fig. 26; Taf. vii, fig. 223—226.

1913. *Praxillura* A (fragment), McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 116, pl. ii, fig. 1.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870, at Station 8, viz. lat. 48° 13′ N., long. 9° 11′ W., at a depth of 257 fathoms on the Channel slope and in the midst of a northern fauna.

Extends to Sweden (Arwidsson).

The cephalic region of this small form is abruptly truncated, the frontal edge being produced into a flattened, somewhat spatulate, snout, with a rounded anterior border. A slight keel occurs on the truncated region. The anterior end is flexed in the preparation, and behind the mouth is a deep furrow.

Following the head (combined cephalic and buccal region) is a short segment bearing bristles succeeded by another of similar length, and then a slightly longer third. So far as could be observed, these segments bear spines and bristles, the spines being remarkably strong for a form so slender. The fourth and fifth segments are long, and so with those which follow.

The *body* is long, slender, and apparently brightly coloured in life. Posteriorly is a somewhat tapered tail which ends in a blunt cone with the anus dorsal. About three or four unarmed segments occur posteriorly.

A minute account of the coloration is given by Arwidsson, showing that the first bristled segment is citron-yellow, the dorsal surface of the head chrome-yellow. The second segment and the feet are citron-yellow, with specks on both, and this and the following segments are red with yellowish-brown. The third segment is deeper yellow with specks especially posteriorly, and so with the fourth. The fifth is pale yellow with specks. The sixth has very few specks, but these are deep red on the posterior part.

The seventh is citron-yellow, sparsely speckled with red. The eighth is yellowish. The succeeding segments are transparent.

The typical hook (Plate CVIII, fig. 1) is minute, with a moderately long, curved shaft, a marked shoulder, proportionally large great fang which makes rather less than a right angle with the neck, a gular bristle which arises after an interval from the throat and only splits at the tip, and four or five teeth on the rather elevated crown. The line between the base of the main fang and the origin of the gular bristle is incurved, and the neck has a considerable inclination backward from the shaft, so that the outline of the hook somewhat resembles that given by Arwidsson for *Praxillura longissima*, though the crown differs from that form and agrees with *Lumbriclymene minor* of the same author. The bristles consist of stouter winged forms with tapering tips and more slender ones with hair-like tips. So far as could be seen both had smooth edges in spirit-preparations.

The tube consisted of secretion, with grains of sand and minute fragments of shells.

A fragment of this form was described as pertaining to a *Praxillura*, but a more complete specimen showed that it belonged to a small *Lumbriclymene*, probably *L. minor*, and in this Prof. Arwidsson, who kindly examined the specimen, agrees.

Genus CXV.—Praxillura, *Verrill*, 1879.

Cephalic region with eyes. Nuchal organ small, curved. Anterior short segments somewhat numerous, with the feet in the anterior part of each. Nephridia in anterior segments. The posterior end is small, with a central anus. The feet have more or less developed glandular belts. The anterior segments have spines, and the number of these varies, the last one or two presenting a few modified hooks. Tube free, straight.

Praxillura C. Fragment. Plate XCIX, figs. 7 and 7 *a*—anterior end.

Habitat.—Dredged at Station 16 off the coast of Portugal in 994 fathoms in the 'Porcupine' Expedition of 1870.

The cephalic region is shaped somewhat like that of *Nicomache*, bluntly conical in dorsal view, and produced and tapered ventrally in profile. The mouth is in a longitudinal groove ventrally.

The *body* is thread-like, probably about an inch and half in length, with shorter segments anteriorly and longer toward the posterior third, but the posterior end is absent.

The bristles have rather narrow wings and tapering tips of the usual kind. The typical hook (Plate CVIII, fig. 11) has a short neck and a well-marked shoulder, a main fang which leaves the neck nearly at a right angle with four distinct teeth above it, and traces of a fifth and sixth. No gular bristles are present.

The tube is friable, straight, has an inner layer of translucent secretion, and an outer one of Foraminifera and fine sand.

Genus CXVI.—Notoproctus, *Arwidsson*, 1906.

The nuchal organ forms a large curve. Proboscis a somewhat large, flattened sac. Anterior segments short, with the feet anteriorly. Bristled segments distinct. Body

a little narrowed posteriorly, and terminating in a slightly oblique plate with smooth rim, the anus being over its dorsal margin. Nephridia in several segments. Well-developed glands on the ventral surface of the anterior segments. Some of the anterior segments, besides the spines, show modified hooks. The hooks have several hairs (gular). Tube free or slightly fixed.

Notoproctus. Fragment. Plate CVIII, fig. 2—hook.

A fragment came from a station off Cape Guardia in forty-five fathoms, in the 'Porcupine' Expedition of 1870, and in this the hooks are remarkable for the erect condition of the teeth above the great fang (Plate CVIII, fig. 2), thus somewhat approaching certain species of *Nicomache*. It is a form of some size.

Genus CXVII.—Rhodine, *Malmgren*, 1866.

No cephalic plate; buccal and first setigerous segment connate, tapered to a conical point. A short keel between the nuchal organs. No eyes. Body sub-cylindrical; number of segments thirty-five to thirty-seven (Tauber and Arwidsson). First bristled segment narrowed posteriorly, and so with the two or three following. Feet in the middle of bristled segments one to eight. The groove between segments 9 and 10 (bristled) is absent or indistinct. The following segments are long. Segments 2 to 9 furnished with glands. Anus central in an anal plate. Proboscis with transverse rows of papillæ. Capillary bristles smooth, the longer with narrow wings; the shorter with broader wings. Hooks absent in the four anterior segments, but commence on the fifth, in the rest biserial, with a short shaft widening to the shoulder, above which is an anterior pointed process. The main fang is long and curved, and several teeth occur on the crown above. A small free tube.

1. Rhodine gracilior, *Tauber*, 1879. Plate XCIX, fig. 8—segment; Plate CVIII, figs. 3 to 3 *b*—bristles and hook; Plate CIX, fig. 1—hook.

Specific Characters.—The anterior region of the body (two bristled segments) somewhat long and small. The collar of bristled-segments two and three not emarginate dorsally. The posterior collar begins at the seventeenth bristled segment. The collar at the posterior end very short and dorsally crenulate, with a median bite. Nephridia in bristled segments 5 to 9. The third bristled segment has behind the collar a well-developed glandular belt, and a less developed glandular area behind the foot. No glandular belt behind the posterior collars. The hooks are in a double row from the fifteenth segment inclusive, and they somewhat resemble those of *R. Loveni*, but the process behind the great fang is shorter and the great fang larger. Colour, reddish in front, with brownish glandular belts, which have a small white rim in front, and a similar but broader border occurs on the lateral dorsal region behind the feet. A white band also is situated dorsally behind the feet of segments 4 to 7, and in several

of the succeeding segments. Behind these are a reddish point and seven to eight bristled segments. Tube rigid, encrusted with sand.

Synonyms.

1869. *Rhodine Loveni*, var., McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 420, pl. xv, fig. 16.
1879. „ „ var. *gracilior*, Tauber. Annul. Danic., p. 123.
„ „ „ var. *breviceps*, idem. Ibid., p. 123.
1906. „ „ Arwidsson. Skand. u. arktisch. Maldan., p. 74, Taf. ii, figs. 53—58; Taf. vii, figs. 237—241; Taf. viii, figs. 242—243.
1913. „ „ var., McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 85.
„ „ *gracilior*, Nolte. Wiss. Meeresuntersuch., N. F., Bd. xv, p. 19, Taf. i, figs. 1 and 25; Taf. ii, fig. 26, text-fig. 4.

Habitat.—Dredged off the Hebrides by Dr. Gwyn Jeffreys in June and July, 1866.

Abroad it is found off Sweden, Norway, Spitzbergen, and off the Faröes.

As only softened fragments have been procured in the British seas, the following brief account of the external aspect is after Arwidsson.

Cephalic region bluntly conical in front, forming a short cone when viewed from the dorsum, and a flattened beak when seen laterally. The nuchal grooves run forward on each side of the short keel, and then curve outward and slightly backward to the margin. The condition of the proboscis is unknown.

The body is of variable length, Arwidsson mentioning one of 47 to 50 mm. in length and 2 mm. in diameter, and with thirty-five bristled segments. The first bristled segment is long, and the collars of the two following segments are shorter dorsally than ventrally. These collars have a smooth edge in the living form, but are crenated when preserved. The collars (Plate XCIX, fig. 8) extend to the seventeenth segment inclusive. Behind the bristled segments are one or two devoid of bristles, and the body ends in a blunt papilla with the anus beneath.

The Nephridia occur in bristled segments 5 to 9.

Few glands occur on the head. On the first bristled segment is a glandular band at the feet, and so with the second, and glands occur on the inner side of the collar. On the third segment the band is broader, and so in segments 4 to 9. The glands are continued posteriorly at the hook-rows, and also occur on each side of the ventral ridge (nerve-cord).

From the fifth to the fifteenth bristled segment the hooks are in double rows, and though similar to those of *R. Loveni* (from the 'Valorous' Expedition) they are distinguished by the shorter spike-like process behind the great fang (Plate CVIII, fig. 3 *b*, and Plate CIX, fig. 1). Above the main fang are more numerous teeth than in Arwidsson's figure,[1] and instead of the short conical point the British examples had a process at the tip of the cone, though much less than in *R. Loveni*. A tendency to a truncated instead of a smoothly-rounded prow was also noticeable, as well as a slightly sinuous margin just behind or below the prow, as indicated in the figure. The whole aspect of the anterior regions of the respective hooks differs, the great fang is much larger proportionally,

[1] Taf. vii, fig. 237.

and the shaft of the hook is, as a rule, less curved than in *R. Loveni*. They became smaller and smaller posteriorly.

The anterior bristles are in two groups as in *R. Loveni*, the anterior (Plate CVIII, figs. 3 and 3 *a*) having broader wings, with a long, tapering tip, and the posterior bristles have narrower wings.

The Hebridean example (1866) was in fragments, softened, and without head or tail, but it evidently belonged to a form of considerable size for the family, and its bristles were exceptionally strong. It is often difficult to determine the distinctions of closely allied forms where the specimens are fragmentary, and where descriptions and figures are capable of various interpretations.

Tauber (1879) mentions three varieties, the infundibuliform posterior segments being long in the first and stouter variety, shorter in the more slender forms, and in the third considerably shorter.

Arwidsson (1906) in his comprehensive survey of the northern Maldanidæ more clearly defined this species from *R. Loveni*, yet in regard to the hooks there are certain differences between the British and the more northern examples which need further investigation.

Nolte [1] (1913) gives longitudinal sections of the collar and the collar-organ of *Rhodine Loveni*. The latter is situated at the inner edge of the base, and consists of hypodermic cells, nerves, and muscular fibres covered by cuticle.

The same author has a figure of a bristle of this species in which he speaks of the capsule which in his figure is separated from the shaft at a fractured part, the interior of the shaft being fibrillar.

Sub-family.—Nicomachinæ, *Arwidsson*, 1906.

Nuchal organs more or less bow-like, diverging anteriorly. Cephalic plate absent. First bristled segment short, those following to the eighth longer, those near the tail shorter, segment-junction absent between the seventh and eighth segments. Anal cup with well-marked cirri, a larger one in the mid-ventral line. Anus in the centre of the cup. Nephridia in several segments. Glandular belts anteriorly in bristled segments 1 to 7. Spines in single row in segments 3 to 4. Hooks in a single row in the first series, with a bold curve at the neck, a great fang with several spines on the crown, and a tuft of hair on the throat. Anterior bristles with narrow wings and some with long, tapered tips and minute spines. Others with slender axes and opposite spikes. The posterior long bristles have their tapered tips smooth. Tubes of sand, free.

Genus CXVIII, Nicomache.[2] *Malmgren*, 1866.

Cephalic lobe fused with the bare buccal segment, oval, convex, inclined, without a border. Body sub-cylindrical, slightly attenuated posteriorly, segments twenty-six, of

[1] 'Wiss. Meeresuntersuch,' N.F., Bd. XV, p. 83, figs. 26 and 27.

[2] Arwidsson again makes *Nicomache* a sub-genus, characterised by the anal funnel being slightly oblique, and the border with short cirri; nephridia in the sixth bristled segment.

which twenty-two are setigerous; two short pre-anal segments devoid of bristles. Anal plate infundibuliform, with short cirri on the margin. Anus in the middle of the funnel. Upper capillary bristles in some stout, winged, with an attenuate apex; others more slender, shorter, devoid of wings, but with opposite spikes. Inferiorly in three anterior segments only a stout spine, in the rest uniserial hooks with three spines above the main fang, and with a capillary fascicle on the throat below (Malmgren).

1. Nicomache maculata, *Arwidsson.* Plate XCII, figs. 5—5 *a*—head and body; Plate CIX, figs. 2—2 *a*—bristle and spine; Plate CX, fig. 13—hook.

Specific Characters.—Anterior end bluntly-rounded dorsally, but with a projecting process ventrally. Nuchal grooves on each side of the low median ridge, and they curve outward anteriorly. In the concavity of each externally is a dark pigment-spot. Minute eye-specks occur on the sides of the mouth anteriorly. Body about 2 in. long, more or less rounded dorsally, but a ventral groove occurs posteriorly; twenty-two bristled segments, the first three of which have only powerful, fusiform, straight? spines, and segments 4 and 5 have a reduced series of hooks which are not quite typical in shape though both may also have spines. Anterior region with numerous glandular areas, which posteriorly chiefly affect the feet. Anal funnel forming a deep cup with fifteen to twenty-one angular processes or cirri on the margin, the anus being in the centre; occasionally a few smaller processes alternate with the others. One or two narrow rings behind the last bristled segment. Segmental organs in segments 6 to 9. Speckled with madder-brown anteriorly, or with white on a brownish ground. Transverse S-shaped bar of white dorsally on snout. Fourth bristled segment sometimes, and occasionally the whole anterior region, crimson. Often with a whitish belt between seventh and eighth segments. Pale straw colour posteriorly, the anal funnel being dotted with white grains.

Bristles of two kinds; stronger capillary with minutely serrated wings, and more slender anterior forms with long hair-like tips and opposite spines, the shaft being smooth. Both continue to the posterior end. Spines of the three anterior segments fusiform, with a powerful golden tip and strong muscles. Hooks with a moderately long, curved shaft, striated internally, a marked shoulder posteriorly, neck constricted above the shoulder, then curved backward and widening distally, the great fang coming off at somewhat less than a right angle, whilst the crown is high and presents in lateral view five teeth.

Frequents fissures of rocks in tubes of mud or muddy sand lined by secretion, or has free tubes of mud or occasionally hardened with other materials.

Synonyms.

1853. *Clymene borealis,* Dalyell. Pow. Creat., vol. ii, p. 255, pl. xxxv, fig. 5.
1869. *Nicomache lumbricalis,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 420.
„ *Clymene* (*Praxilla*) *lumbricalis,* Grube. Mitt. St. Vaast, Abh. Schles. Ges., 1868—69, p. 37.
1874. *Nicomache lumbricalis,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875. „ „ idem. Invert. and Fishes St. Andrews, p. 127.
1888. „ „ Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 678, pl. xlvii, fig. 41.
1891. „ „ Hornell. Trans. Biol. Soc. Liverp., vol. v, p. 251.

1896. *Nicomache lumbricalis*, Benham. Camb. Nat. Hist., vol. ii, p. 332.
1911. „ *maculata*, Arwidsson. Proc. Roy. Irish Acad., vol. xxix, p. 209, pl. xviii, figs. 13—19, and pl. xix, figs. 27—30.
1912. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 86.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 134.

Habitat.—Abundant between tide-marks at the East Rocks, St. Andrews, in tubes of sand in fissures of the rocks; under stones near Paible, North Uist, near low-water mark; very common at Herm, near the harbour, where the sand is so crowded with their tubes as to be almost bristled with them, and thus affording a tempting feeding-ground for waders and other sea birds. Small examples occur in tubes of mud, shell-fragments, sand-grains, and secretions on the outer and inner surfaces of valves of *Pectan opercularis* in Shetland (J. G. Jeffreys). In six to eight fathoms in the West Voe of Burra, Shetland, in long tubes of secretion, sand-grains, and minute shell-fragments, the tube ending posteriorly in a blunt point. At St. Andrews it is common in fissures of the shale inhabited by *Pholas*, in tubes of sand which may form coherent sandy masses. The inner lining of the tube is dark brownish or madder brown, whilst the sand-grains in some cases are ochreous. It is equally common in Ireland on both eastern and western shores (Arwidsson, Southern). It is probably the species mentioned by Grube at St. Vaast, and may be found extensively distributed elsewhere on the European shores.

De St. Joseph (1906) describes the segmental organs as four pairs, in segments 4 to 8, and attached near the ventral nerve-cord on the one hand and the body-wall on the other. They are the organs of Bojanus of Cosmovici. The axis is occupied by a ciliated canal, which opens on a papilla at the extremity of a torus near the ventral median line.

The anterior end (Plate XCII, figs. 5 and 5 *a*) is somewhat bluntly truncated, rounded in the living form, but in the preserved condition it presents inferiorly a somewhat shovel-shaped short projection. Viewed from the front in the preparations the pigmented peristomial segment terminates dorsally rather abruptly, the pale cephalic keel passing downward and forward and being lost on the symmetrically expanded snout. The nuchal grooves occupy each side of the ridge and curve outward at their anterior end, whilst the madder-brown pigment in its symmetrical disposition often mimics an eye on each side. The minute eye-specks are situated in a row on either side of the anterior border, between the tip of the nuchal groove and the ventral edge. The fusion of the pro- and peristomial segments is close, and both would seem to take part in the formation of the anterior process, for the symmetrical furrows from the mouth occur on its under surface. The mouth forms a transverse furrow posteriorly, whilst in front a median and two lateral furrows pass forward to the snout. In examples in which the head has been recently regenerated the parts are pale, the anterior process or prow is shorter and has a median dimple.

In contrast with the foregoing the snout of the northern *N. lumbricalis* is less produced anteriorly, a condition very evident in a lateral view. Moreover, antero-posteriorly *N. lumbricalis* has a more rounded and less elevated crown, whereas in *N. maculata* the crown is higher and narrower. There is no specialisation of pigment as in *N. maculata* in separate touches, though the upper or dorsal half is reddish-brown and the lower

[1] 'Ann. Sc. nat.,' 9e sér., t. iii, p. 173.

whitish. The nuchal grooves in *N. lumbricalis* have a similar trend to those of *N. maculata*, curving gently outward anteriorly, and separated by a flattened ridge.

In the large Canadian *Nicomache* the aspect of the snout diverges still more, for behind the median ridge is a deep fold of the segment, the ridge itself commencing by a rather broader base, and slightly narrowing, slopes downward and forward to within a short distance of the anterior edge. In lateral view a convexity exists in the middle. The nuchal groove closely follows the somewhat narrow ridge and thus they converge, since the ridge itself is narrower in front. The groove turns sharply outward on each side, making a small angle with the main furrow, and this differs from either *N. lumbricalis* from northern Europe or *N. maculata*, in both of which the curve is bold and rounded.

Immediately behind the mouth in *N. maculata* is a transverse furrow indicating the anterior border of a narrow segment devoid of bristles. It is marked by a distinct band of pigment on the dorsum, at a distance behind that at the anterior border of the peristomial segment.

The next three segments are each distinguished by having dorsally a tuft of bristles and ventrally a single powerful golden spine close to the ventral side. The dorsal tuft consists of a few capillary bristles with tapered tips, some of the larger and more delicate having opposite spikes. The ventral division has a single powerful spine or two of great proportional size and of a light golden colour (Plate CIX, fig. 2 *a*). The general outline of the spine is fusiform, the tip tapering to a strong and rather blunt point of a deep yellow colour by transmitted light. The spine dilates from the tip downward to the middle and again tapers to a blunt end inferiorly. The central and inferior regions are closely striated, and in some marked by transverse lines, whilst the fine striæ pass upward almost to the tip of the spine. Powerful muscles are attached to the spine, sloping from the base of the organ obliquely outward. In the preserved examples the three sets of hooks project prominently outward on a papilla, each from its segment about midway between the dorsal and ventral borders.

Dorsally the anterior end is pale with madder-brown grains, or speckled with white on a brownish ground. A transverse **S**-shaped bar of white occurs on the snout dorsally, the bars meeting in the middle line. The fourth bristled segment is often tinted crimson, whilst in others the whole anterior region is so, the general hue of the body behind being dull orange, marked dorsally by the median blood-vessel, and most show a tendency to a whitish belt between the seventh and eighth segments. The anal funnel is dotted with whitish grains internally. Those from Lochmaddy had a dark-brown snout, the brownish hue in front becoming pale straw-colour posteriorly at the anal funnel.

The anal cup (Plate XCII, fig. 5) forms a circular funnel with a series of short and somewhat triangular processes or cirri, nineteen to twenty-one in number, and of a general uniformity, though variations occur, one example presenting a continuous series of eight or nine smaller cirri. The cup slopes evenly to the centre, in which is the anus. The dorsal edge of the funnel externally is the shorter. In front of the anal funnel are one, or two, narrow rings.

The bristles form a double group, a ventral series of stronger capillary bristles with wings, and a dorsal (Plate CIX, fig. 2) of more slender, finely-tapered forms, with opposite spikes and a smooth shaft. The first three bristled segments have a dorsal series of the

usual kinds of bristles, and a short distance beneath a single powerful spine, which appears to be of special service to the annelid in its movements of extension beyond the tube. The strong sharp points would instantly anchor the body either by impinging on the tough lining of the tube or other hard surface externally.

The fourth and fifth feet also occasionally have two of the strong spines, and the former has a few hooks which differ from the typical forms behind in the greater proportional size and elongation of the main fang and the upright position and blunt condition of the spikes on the crown. The fifth foot has a large number of hooks. In other examples the spines only extend to the fourth. The tuft of bristles on the throat is also close to the base of the main fang, and the general outline of the neck, shoulder, and short shaft differs.

In the sixth segment the bristles and hooks are anterior; in the seventh they are also anterior, and there is no furrow between this segment and the eighth. In the following segments the bristles and hooks are posterior, and they continue so to the fourth segment from the end of the series. The last three are short segments, and they bear their bristles and hooks on the mid-lateral region. Most show a single ring between the last bristled segment and the anal cup, but one shows two.

The bristles of the last segments consist of rather strong capillary forms with distinct wings and tapered tips which show no spikes, and a few more slender forms of the usual character, with long, fine, hair-like tips and opposite spikes.

The typical hook (Plate CX, fig. 13) differs from that of *Nicomache lumbricalis* and of Arwidsson's var. *borealis*. The great fang makes a smaller angle with the neck, and five teeth occur in lateral view on the crown above it. The backward curvature of the neck is as great as in var. *borealis*, but the neck is longer, and the shoulder beneath it is perhaps better defined. The tuft of bristles on the throat is separated from the fang by an interval as great as in var. *borealis*. The hooks form a single row in each case, the rows being short in the anterior segments, but at the seventh bristle-tuft each lies in the centre of a long, elevated, glandular mass on the ventral surface, those following gradually becoming ventro-lateral in position, and separated from each other by a furrow in the mid-ventral line. The hooks project from the surface and thus give most efficient anchorage when in action. By the elevation of the pads the hooks in projection form a curved ridge of golden points, and in life this can always be accomplished by muscular agency. When loosened in their surroundings they entangle delicate forms like the Ampharetidæ, and it is difficult to remove these without rupture.

Nicomache lumbricalis, which has sometimes been confounded with the present species, is an arctic form which does not appear to extend to British seas.[1] In the large examples of *Nicomache lumbricalis* procured in the 'Valorous' Expedition of 1875 the neck of the hook is shorter and more uniformly broad, the striæ are confined to the beginning of the distal region, the main fang makes a larger angle with the neck, and only three teeth are usually visible on the crown in lateral view, and they are more erect. This form makes a nearer approach to the hook of Arwidsson's var. *borealis*. The large Canadian form, again, shows a much longer shaft, larger neck which widens distally at the striated region, the main fang has a similar angle with the deck, and two teeth with traces of a

[1] *Vide* Arwidsson, 'Zool. Anzeiger,' Bd. xxxiii, 1908, p. 270.

third occur on the crown—those in front being considerably altered. The striæ in these occupy the greater part of the neck. Moreover, there are no gular bristles, so that there can be no confusion.

It seems doubtful if Arwidsson's species—*Nicomache minor*, *Nicomache trispinata* var., *Nicomache quadrispinata*—are other than varieties, for in the common form four spines sometimes occur, and so with eyes. The only approach to Arwidsson's *Nicomache quadrispinata* is the occasional presence of four segments with spines in the common *Nicomache maculata*, the pigment of which on the head occasionally simulates eyes. In certain of these the spine is transversely and somewhat regularly striated.

Reproduction.—Arwidsson found a large male from Howth near sexual maturity in October.

A young form, 3 or 4 mm. in length (posterior end being absent), occurred in Ardmaddy Bay, Lochmaddy, on the 13th August, 1872.

Habits.—It is a brittle species, comparatively few being collected in a perfect condition. Thus regenerated anterior and posterior ends are common in this as in other Maldanids. The intestine is filled with the greyish mud of its habitat in which sand-grains, sponge-spicules, diatoms, radiolarians, and other *débris* abound.

Tube composed of mud or sandy mud, lined by secretion, in the fissures of rocks. Arwidsson found the tubes from Blacksod Bay, Ireland, composed of small, light-coloured grains of sand, occasionally with shells of small mussels.

It is difficult to say what the *Clymene amphistoma* of Delle Chiaje[1] is, for he represents only the posterior end projecting from its tube of sand. It is probably a littoral form and may be this species.

Dalyell (1853) apparently refers to this species under the name *Clymene borealis*, and he says it is not rare in rocky clefts near low water, and has twenty-four segments. He thought the teeth of the anal funnel might be instrumental in fashioning its hard sandy tube during the night, but this is conjectural.

A funnel dredged in 30 fathoms, Gaspé Bay, in 1873, resembles nothing hitherto seen, and may be that of a *Nicomache*. It forms a short vase with three unarmed rings in front of it—all equally prominent, and marked by elevations indicating the mid-ventral streak, which is continued on the funnel rather to the left of a short cirrus. The cirri are short broad cones, and, for the size of the funnel, few in number, viz. fourteen. One on the left has its apex produced as a short filiform process. The anus opens in the centre without an anal cone, but with nine short furrows radiating from it.

De St. Joseph (1894) mentions the occurrence of *Donusia clymenicola*, a parasitic copepod, on a form which is probably *Nicomache maculata*.

Genus CXIX.—Proclymene, *Arwidsson.*

Nuchal organ hook-like; straight limb, short and deep. Margin of cephalic plate feebly developed. Naked segments large posteriorly; between the last and the anal funnel is a wider part. Anal cirri short and triangular, with two larger ventral cirri and

[1] 'Memorie' and 'Descrizione' (*e.g.* Descriz., pl. lxxx, fig. 3).

the commencement of the ventral streak between them. Glands occur at the feet in all the anterior segments, and dorsally and ventrally in segments 5 to 8; the anterior bristled segments with spines. Hooks long, slightly curved, with long necks from which the main fang comes off at more than a right angle. Gular bristles arising from cheeks at base of the great fang, and spreading upward and outward as a broad fan. Anterior bristles slender, with narrow wings and smooth points; posterior bristles with short, smooth points. Tube free, straight.

1. Proclymene Müllerı, *Sars*, 1851. Plate XCIX, figs. 2—2 *c*—head and anal cone; Plate CIX, figs. 3—3 *d*—bristles and hook; Plate CX, fig. 2—hook.

Specific Characters.—Cephalic plate sloped from behind downward and forward, ending in front in a central conical process with a flap on each side. A short narrow keel passes backward from the central process, but does not reach the middle of the plate. Short and deep nuchal grooves on each side of the keel, curving outward anteriorly, and being lost within the margin of the plate, which is thick, little extended, and slightly crenate. Body rounded dorsally, slightly flattened ventrally, as well as marked by a median groove. Nineteen bristled segments, and five posterior without bristles. The anal funnel has two long cirri ventrally, the rest of the margin with small cirri (twenty-six, Arwidsson; fifteen to twenty-three, Sars).

The proboscis is much wrinkled, but it appears to be comparatively smooth. The feet are at the anterior part of bristled segments 1 to 9, but from the eleventh backward are at the posterior border. The bristles are of two kinds—a powerful series with strong, straight, golden shafts and slightly curved tapering tips with distinct wings, and a slender series having tapered tips and just an indication of wings. The typical hook has a long, slightly curved shaft, which dilates from the base to the shoulder, the long neck being narrowest in the middle and having a knob on the throat below the great fang which comes off at more than a right angle and has about five teeth on the crown above it. The gular bristles spring from the cheeks at the base of the main fang and extend obliquely upward and forward on each side. Segmental organs in segments 6 to 8, with openings in the ninth bristled segment (Arwidsson).

Synonyms.

1851.	*Clymene Mülleri,*	Sars.	Nyt Mag. f. Naturvid., vol. vi, p. 201.
1853.	„	„	idem. Ibid., vol. vii, p. 390.
1856.	„	„	idem. Fauna Lit. Norveg., ii, p. 13, Tab. 1, figs. 1—7.
1861.	„	„	idem. Christ. Vid.-Selsk. Forhandl. (sep. copy), pp. 21, 91.
„	„	„	Danielssen. Nyt Mag. f. Naturvid., vol. xi, p. 54.
„	„	„	Sars. Ibid., vol. xi, p. 256.
1865.	„	„	De Quatrefages. Annel., t. ii, pp. 240, 657.
1867.	*Praxilla*	„	Malmgren. Annul. Polych., p. 100.
1874.	„	„	Malm. Vet.-o.-Vitt. Samhälets i. Göteborg Handl., vol. xiv, fig. 6.
1875.	„	„	Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, pp. 26, 63.
1879.	„	„	Tauber. Annul. Danica, p. 124.

1882.? *Præxillella Mülleri,* Verrill. Trans. Connect. Acad. Arts Sc., vol. iv, pt. 2, p. 295.
1883. *Clymene* „ Levinsen. Vidensk. Meddel. Nat. For., p. 144.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 114.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 142.
1906. *Proclymene* „ Arwidsson. Skand. u. arktisch. Maldan., p. 129, Taf. iii, figs. 91—97; Taf. viii, figs. 273—275; Taf. xi, fig. 350.
1913. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 90.

Habitat.—Dredged in 78 fathoms off the Outer Skerries, Shetland, in 1868, by Dr. Gwyn Jeffreys. Coast of Northumberland (Prof. G. S. Brady), 1863.

Abroad it extends to Norway (Malmgren); Finmark; Labrador (Verrill); Sweden (Malm, Arwidsson.)

Head (Plate XCIX, figs. 2, 2 *a*—2 *b*) distinguished from that of *Præxillella* by the narrow rim of the cephalic plate, thus making the anterior process and the keel prominent. The cephalic plate slopes from behind forward and downward, terminating anteriorly in the median process which is as prominent as in *P. prætermissa*, but instead of being bounded by the fissure between it and the cephalic rim it is continuous at its base with an accessory fold on each side, within which the anterior curve of the nuchal organ is situated. Arwidsson[1] makes no differentiation of the base of the anterior process, so that something depends on the preparation if variation does not occur. From the median process a short and narrow keel extends backward, but it does not reach the middle of the cephalic plate. On each side of the keel is the short though deep nuchal groove, which terminates anteriorly by curving outward and being lost behind the accessory fold on each side of the central process. The rest of the surface of the cephalic plate is smooth. The margin of the slightly hollowed cephalic plate is comparatively thick and little raised, and though slightly crenate it has no distinct notch. Yet in the preparation a shallow groove runs from one of the crenations in the mid-lateral region, and also extends to the first bristled segment.

The fused prostomial and peristomial region is narrow dorsally but wide ventrally, and has the mouth as a somewhat triradiate opening beneath the median process which is grooved by the anterior depression from the mouth. The posterior lip is transverse and prominent. The proboscis is wrinkled, but the surface appears to be smooth.

The *body* is rounded dorsally, slightly flattened ventrally, and marked by a ventral streak. Arwidsson gives 165 mm. as his longest example. The largest British specimen is imperfect (eleven anterior bristled segments) and it measures 70 mm. It would thus not be far behind Arwidsson's example.

The characteristic funnel (Plate XCIX, fig. 2 *c*) was dredged by Dr. Gwyn Jeffreys ten miles off Balta in 60 fathoms in 1868. It had been severed close to the base, no trace of the adjoining tissues remaining. Twenty-eight of the shorter, flattened conical cirri, which are flexible and comparatively large, occur on the margin, a slightly convex portion accompanying the rim between the two longer on each side of the mid-ventral line. Each of these longer forms has a larger flattened base than the ordinary cirri, then the tip is filiform with a probe-point. Fine lines radiate from the central anal opening, but they are much more numerous than the notches between the cirri. A slight ridge passes from

[1] 'Skandin. u. arktisch. Maldan.,' Taf. iii, fig. 93.

the low anal cone to the mid-ventral line, and outside the anal cone is another ring in the preparation.

The original description of the species by Sars (1851) is quite sufficient for its discrimination.

Arwidsson mentions that the fourth and fifth bristled segments are dotted with yellowish-red points, and the sixth with more distinct touches. In a fragmentary example from the Northumberland coast the mid-dorsal line has a distinct pink streak (from the dorsal blood-vessel ?).

The first bristled segment is narrow and carries laterally a strong spine or two and a tuft of short bristles near its anterior border. This spine has a striated central region, increases in diameter from the base to the shoulder, and then diminishes to the hard golden point. The second bristled segment is longer, has a fold toward its anterior border behind which (fold) the spine or spines and bristles on each side are placed. They thus are situated a little in front of the posterior boundary of the anterior third. The third segment is slightly shorter, has its fold somewhat nearer the segment-junction and also bears a spine or two and bristles on each side immediately behind the fold. The fourth segment is similar in regard to the bristles and spines, and they are placed in the anterior third. A change occurs in the fifth bristled segment, in which a short row of hooks is found in a pit on the ventral surface on each side close behind the segment-junction, and the same occurs in the sixth and seventh bristled segments. The eighth presents elevated glandular ridges at the anterior border for the hooks, the bristle-tuft being at the dorsal end, and so with the ninth segment. The tenth foot is somewhat peculiar in position, appearing at what seems to be the segment-junction. The eleventh, however, is clearly at the posterior end of the segment, which in this case coincided with the end of the fragment.

The bristles consist of a group of powerful golden capillary bristles (Plate CIX, fig. 3) which have a nearly cylindrical shaft and a tapered tip with well-marked wings, besides a few slender, translucent forms which taper terminally without traces of wings (fig. 3 *c*, the anterior of Arwidsson). The hooks (Plate CIX, figs. 3 *b* and 3 *d*), which commence on the fifth bristled segment, are distinguished by their great size, the length and curvature of the shaft which gradually dilates from the base to the slight shoulder from which the long, straight, distal region or neck curves off, and as it again dilates a little distally it is narrowest in the middle. The main fang passes off at more than a right angle, and a knob occurs on the throat immediately below, whilst on the crown are five teeth, though all may not be visible. The gular bristles arise at the base of the great fang and the sides of the knob, and slope, or rather curve, forward and upward. The centre of the shaft is longitudinally striated, and the upper part of the neck is boldly striated obliquely, the striæ in the middle and lower part of the neck being less oblique. Little difference is noticeable in the structure of the hooks, though in the first series one or two may be imperfect.

Arwidsson describes the tube as formed either of fine sand or of shell-fragments, fragments of the spines of Echinus, Foraminifera, and larger sand-grains.

Reproduction.—Arwidsson found in August a male and female with reproductive elements fairly developed.

Genus CXX.—Isocirrus, *Arwidsson*, 1906.

The nuchal grooves parallel almost to the front, where they widen. A well-marked cephalic rim, which fails posteriorly, notched laterally. Few naked segments posteriorly in front of the funnel, the edge of which is notched. Ridge of the ventral nerve-cord distinct. Well-marked bands of glands in all the rings in front of the feet and also on the dorsum.

The anterior bristles have narrow wings and smooth or almost smooth points. Behind these are bristles with stouter shafts, straighter tips, and broader wings. The posterior bristles have narrow wings and long points. Shaft of the hooks of moderate length, hairs on the throat at main fang. Tube free, straight.

1. Isocirrus planiceps, *Sars*, 1872. Plate XCIX, figs. 5, 5 *a*, and 5 *b*—head and anal region; Plate CVIII, fig. 4—hook; Plate CIX, figs. 6 and 6 *a*—spine and hook.

Specific Characters.—Cephalic plate resembling that of *Praxillella prætermissa*, but the notches are less deep, and the margin is crenate. Body typical; twenty-five bristled segments; glandular anteriorly; three segments with slightly curved spines; fourth and fifth segments have modified hooks. Funnel with twenty-seven nearly equal short conical cirri. Ring from which it arises massive, and forming a shelf all round, so that the funnel, as it were, springs from a stalk. Nephridia in bristled segments 6 to 9. Anterior glandular belts to the eighth segment inclusive. Bristles of two kinds—strong with tapered tips and wings, and slender forms with pinnate or spiked tips. Typical hook with rather short, curved shaft, well-marked elliptical shoulder, neck broad distally, the main fang having a semicircular notch below it ending in an eminence for the gular bristles. Main fang makes nearly a right angle with neck, and has five to six teeth on the crown behind it.

Synonyms.

1856. *Clymene sp.*, Sars. Fauna Lit. Norveg., p. 17, Tab. 2, fig. 27.
1872. „ *planiceps*, idem. Annel. Christiania, p. 411.
1900. *Euclymene* „ Verrill. Trans. Conn. Acad. Arts Sc., vol. x, p. 655.
1906. *Isocirrus* „ Arwidsson. Skand. u. arkitsch. Maldan., p. 137, Taf. iii, figs. 98—107; Taf. viii, figs. 276—280; Taf. xi, figs. 348—351.
1913. *Isocirrus D*, McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 94.

Habitat.—Dredged by Dr. Gwyn Jeffreys, in 1868, 35 miles off Skerries, Shetland; and in 78 fathoms off the Hebrides, July, 1866.

Abroad it occurs in the Norwegian fjords, off Sweden, and the Cattegat. It ranges also to the Gulf of St. Lawrence, Canada.

So far as a softened though large example from the Hebrides shows, the cephalic plate, while having a general resemblance to that of *Praxillella prætermissa*, differs from it in the crenate condition of the margin and in the shallow nature of the notches, both lateral and posterior; yet in some large examples of *P. prætermissa* a crenate margin is

also present. The keel, nuchal grooves, and frontal process are similar. No example is perfect, but accompanying the anterior region is a detached funnel and adjoining unarmed segments (four) which apparently pertain to a form of similar size, having twenty-seven equal, or nearly equal, short conical cirri. The funnel is much softened, and no anal cone is visible. In another fragment of the posterior end of a smaller example a funnel occurs with a nearly similar number of cirri of like shape. An anal cone, slightly pentagonal in form and somewhat eccentric in position, is present in this case. In a funnel from the Skerries, Shetland, of similar size to the last, only twenty-three cirri occur, and the anal cone is slightly marked. A feature in all the examples is the massive condition of the ring at the base of the caudal funnel, for it forms a firm projecting shelf, from the centre of which the base of the funnel arises. The cirri, moreover, stand stiffly out.

The *body* is typical in form, the first eight bristled segments anteriorly being furnished abundantly with glands in belts, and the fourth segment has a collar anteriorly. The first three segments are provided with spines, each of which shows a curvature of the shaft, and the tip (Plate CIX, fig. 8) is rather acute, especially in the third set. In the fourth segment is a characteristic row of hooks, which differ from the typical chiefly in the greater length of the shaft, the diminished breadth of the neck distally, and in the rudimentary condition of the gular bristles. The main fang also makes a larger angle with the neck. The typical hook (Plate CIX, fig. 6*a*) has a somewhat short, curved shaft, a well-marked elliptical shoulder, which gradually enlarges from below and diminishes above—toward the neck; the latter then gently enlarges into the broad distal region with the moderately high crown. The feature most distinctive, however, is the semicircular notch below the great fang and its termination inferiorly in an eminence from which the gular bristles spring, then slope obliquely upward to the tip of the fang, and curve above it. The sharp main fang has a marked distal curvature, and stands nearly at a right angle to the neck. At least six teeth occur in lateral view on the moderately elevated crown behind the main fang, and the neck is boldly and obliquely striated, whilst the somewhat slender shaft is longitudinally striated. The stronger bristles have nearly straight shafts with tapered and often curved tips and distinct wings. The slender forms have spinous tips and smooth shafts.

2. Isocirrus DA, *McIntosh.* Plate XCIX, figs. 4 and 4 *a*—anal disc: Plate C, figs. 14 and 14 *a*—head; Plate CIX, fig. 9—hook; Plate CX, figs. 1 and 1 *a*—bristle and hook.

Synonym.

1913. *Isocirrus DA,* McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 95.

Habitat.—Montrose Bay, April, 1869 (Dr. Howden); off Cape Guardia, 'Porcupine' Expedition, 1870.

Another form of *Isocirrus* (DA) of which only fragments of the posterior end with the funnel came from Montrose Bay in April, and, along with *Prællella prætermissa*, off Cape Guardia in the 'Porcupine' Expedition of 1870. Both belong to large forms of

about the same size. Both have an elevated ventral streak, which passes to the edge of the funnel, and both have short, stiff, conical cirri, which in that from Montrose Bay are thirty in number, whilst in the more beautiful specimen from the 'Porcupine' there are thirty-seven more acutely conical cirri. A slight anal cone is also present in the example from the 'Porcupine,' but this is due to differences in contraction during life. Minute processes surround the anal aperture. The firm rim or shelf from which the caudal funnel arises is the same in both, and it has in front of it two unarmed segments with lateral glandular areas.

The hooks (Plate CIX, fig. 9, and Plate CX, fig. 1 *a*) are comparatively large in the posterior region, the shafts are but slightly bent, the shoulder is moderately developed, and the neck is long. Moreover, the form of the neck is diagnostic, since the prominence from which the strong gular bristles spring is removed from the base of the main fang by nearly its own length, the tuft curving to the tip of the fang and then above it. Whilst the posterior outline of the neck (which is slightly bent backward) is smooth, that in front has the bold prominence of the gular tuft, with the long, smooth sinus running to the fang above it. The crown is not high, has four teeth above the main fang, the first standing at an angle to the great fang, the neck is obliquely and the shaft longitudinally striated.

Prof. Arwidsson, after a careful examination of this and other examples of *Isocirrus*, was inclined to link them together as representatives of a single species, and perfect specimens can alone remove all doubts. In the meantime the general outline of the hooks of this large form and their minute structure warrant special notice.

Genus CXXI.—Leiochone, *Grube*, 1868.

Cephalic lobe much reduced, the margin variable. Distinct naked segments posteriorly. Between the last and the anal cone are several rings and a smooth, short part, with a long, slender ventral cirrus, or two, the dorsal edge being free. Well-developed glandular bands on the anterior segments; the triangle of the belt over the ventral hooks. The ventral bristles of the anterior segments consist of more or less reduced hooks, with hairs under the main fang. The anterior capillary bristles have narrow wings and short, very fine hair-pencils. The points of the posterior bristles are not wider inferiorly. The shaft of the hooks is curved. The external openings of the segmental organs lie behind the rows of hooks. Free and straight tube.

1. Leiochone (Clymene) ebiensis, *Audouin and Edwards*, 1844. Plate C, fig. 18; Plate CIX, figs. 10–10 *b*—bristle and hook.

Specific Characters.—Anterior end pyramidal or somewhat clavate, with a pointed frontal process. Dorsally, only a narrow median keel and two adjacent, parallel and sharp ridges, represent the usual cephalic plate, the ends of the ridges appearing on each side of the frontal process in an antero-posterior view. Between these and the keel are the nuchal grooves. A dense series of minute dark eyes occur on the sides of the snout dorsally, but disappear in front by passing ventrally where they extend forward to the apex. Body from 5 to 6 in. in length, rounded, with a distinct mid-ventral ridge

continued backward to the edge of the funnel. Bristled segments twenty-four to twenty nine, besides five devoid of bristles posteriorly. Anal funnel little dilated, with a smooth rim and a prominent anal cone in the centre.

Both bristles and hooks occur on the first segment, but the hooks are less elaborately formed and are devoid of gular bristles. The typical bristles are in two groups, have stout shafts, finely-tapered smooth tips and distinct wings in the one case, and in the other shorter and more slender forms with hair-like tips. The hooks are comparatively straight, have a short and sharp main fang, and a broad but not elevated crown with six teeth behind the main fang, which has the gular bristles applied to its lower edge. The shoulder is slightly developed. Colour pale yellow, segments two to seven having anteriorly a white band, and behind it a faint reddish belt, which on the seventh is deep red. The ventral surface of the eighth segment has a white cushion (De St. Joseph).

Tube free, friable, composed of sand-grains and minute fragments of shells attached to a central lining of secretion.

Synonyms.

1844. *Clymene ebiensis,* Audouin and Edwards. Règne Anim., Disciples' ed., Annél. p. 47, pl. xxii, fig. 4.
1848. „ „ Œrsted. Region. Marin, p. 79.
1851. „ „ Grube. Fam. Annel., pp. 77 and 137.
1865. *Leiocephalus ebiensis,* De Quatrefages. Annel., t. ii, p. 243.
1868. *Clymene ebiensis,* Grube. Abh. Schles. Gesell. f. vat. Cult., 1867, p. 53.
1869. „ „ McIntosh. Rep. Brit. Assoc. for 1868, p. 338.
„ „ „ idem. Trans. Roy. Soc. Edinb., vol. xxv, p. 422, pl. xvi, fig. 12.
1892. „ „ idem. Ann. Nat. Hist., ser. 6, vol. x, p. 103, pl. viii, figs. 1—4.
1894. ? *Leiochone clypeata,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 139, pl. vi, figs. 167—175.
1896. ? *Clymene lumbricoides,* Benham. Camb. Nat. Hist., vol. ii, p. 333
1913. „ *ebiensis,* McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 96.

Habitat.—Dredged by Dr. Gwyn Jeffreys in 75 to 80 fathoms in the Outer Haaf, Skerries, Shetland, in 1867; in 305 fathoms, Station No. 2 in the Atlantic, and again at Station No. 8 by the 'Porcupine,' 1870; coast of Durham, (Prof. G. S. Brady, 1866); between tide-marks, Jersey (Hornell).

Abroad it occurs on the island of Ebiens on the coast of Brittany in France (Audouin and Milne Edwards) and other parts of the French coast, *e. g.* St. Malo and Dinard (De St. Joseph).

The anterior end (Plate C, fig. 18) forms a smoothly-rounded and somewhat pyramidal or clavate mass, with a pointed frontal process—the prostomium, peristomium, and perhaps the first (unarmed) segments entering into its composition, the two former being separated by a ring from the latter. Dorsally a narrow median keel commences at the ring just mentioned and passes forward to the mid-frontal process. On each side of the keel is a sharp vertical ridge or lamina, which accompanies it to the frontal process where it ends, a front view presenting the ends of the ridges on each side of the frontal process. A deep groove (probably the nuchal) separates them and debouches on each side of the frontal process, and this arrangement recalls the condition in the cephalic plate of other forms. In the fresh example a dense series of minute dark brown eyes is visible from the dorsum on each side of the snout, but they disappear by passing under the pointed

tip, where they extend forward to the apex, and they vanish in specimens long preserved in spirit. Similar groups of eyes are observed in the aberrant *Branchiomaldane Vincentii* of Langerhans,[1] as lately described by Dr. Ashworth.[2]

The mouth opens in the usual position—ventral and posterior to the frontal process. The *body* is of considerable length, viz. 5 to 6 in., rounded, with a distinct mid-ventral ridge, which is continued backward to the edge of the anal funnel, and in one example has twenty-two bristled segments and four devoid of bristles posteriorly. The first bristled segment is about a third longer than the cephalic lobe in a good preparation, and bears about a fifth from its anterior border a small tuft of bristles and ventrally three hooks, the crowns of which are less elaborately formed than in the posterior hooks and are devoid of gular bristles. The second segment is more elongated, and, like some of the segments which follow, is distinguished by an anterior whitish glandular region, the bristles and hooks being at the posterior border thereof, viz. about the anterior fourth of the segment. The two succeeding segments (third and fourth) are similar, but the fifth and sixth are somewhat shorter and thicker—all, however, in the preparation showing the free fold of the anterior border, which in a manner ensheaths the posterior end of the preceding segment. The third segment has a tuft of bristles and four hooks, the tips of which are also rudimentary and the throat devoid of gular bristles. The fourth, on the other hand, has a considerable number of hooks, viz. nineteen or twenty, with normal crowns and a tuft of gular bristles. The seventh has also the free and densely white glandular anterior margin, intensified by the dark hue of the region behind, and the bristles and hooks are similarly placed. Behind the foregoing a change in the arrangement of the segment-junctions occurs since the densely whitish glandular region of the eighth segment passes slightly forward on the seventh ventrally, thus the free margin so characteristic of the preceding segments is lost. The anterior border of this curved white region, however, really marks the segment-junction, though in the specimen from Jersey this feature is not so distinct as in the others, probably from less perfect preservation. The foot of the eighth segment with its bristles and hooks is situated posteriorly, and thus a change in the position of the organs is inaugurated, the segment-junctions immediately succeeding the bristle-tufts from the ninth (inclusive). The last five or six bristled segments are considerably elongated. The posterior end appears to be composed of six segments, four of which have slight glandular elevations to indicate the position of the bristle-tufts and hooks of the other segments, for they are absent in these. The terminal rim or funnel is much expanded, but its edge is perfectly smooth, and the anal cone is in the centre. The whole somewhat resembles the anal funnel of Théel's *Praxilla polaris*. De St. Joseph describes the anal segment as sometimes long, sometimes short, but such would appear to be due to injury and regeneration.

The stronger bristles (Plate CIX, fig. 10) have stout shafts and finely tapered, slightly curved tips with distinct wings. De St. Joseph describes the shorter and more slender bristles as pinnate. This has not yet been seen in the preparations.

The hooks (Plate CIX, figs. 10 *a* and 10 *b*) are remarkable for their comparatively straight shafts, only a slight curvature being present; for the rather indistinct shoulder,

[1] 'Nova Acta Acad. Leop.-Car.,' Bd. xlii, no. 3, p. 116, figs. 21 *a*, etc.

[2] 'Proc. Roy. Soc. Edinb.,' vol. xxxii, p. 62, with plate, 1912.

for the shortness of the main fang, which comes off nearly at a right angle to the neck, and increases in breadth from the shoulder to the crown, and for the flatness of the latter. The main fang is rather short, but acute, and the gular bristles are separated by a short interval from its base, curve to the tip, and then rise above it. Six teeth (as usual in lateral view) occur on the crown behind the main fang, but there is little elevation. The bristles and hooks of segments 13 to 23 are best developed.

Reproduction.—The example procured by the 'Porcupine' at Station 2, 8th July, 1870, was laden with apparently ripe ova.

Young forms of this species occurred in the sticky grey mud of Ardmaddy Bay, Lochmaddy, on August 13th. They were a little more than $\frac{1}{4}$ in. in length, and the most noteworthy feature was the conspicuous nature of the bristles in four of the short segments in front of the caudal process, which was proportionally large. The last three are directed forward, and the tuft in front backward, though much weight need not be placed on this feature.

The tube, which is figured by the original authors, is in the Zetlandic example somewhat firm though friable, and is composed of sand-grains and minute fragments of shells attached to a central lining of secretion.

In the edition of the 'Règne Animal' by the disciples of Cuvier, Milne Edwards introduced as the type of the "Clymènes," Savigny (an abranchiate setigerous group which he associated with the Lumbrici), a new form which was termed *Clymene ebiensis*. No description further than the explanation of the six figures in a footnote is given, but the form is recognisable, and is characterised by the pyramidal shape of the cephalic segment and the absence of cirri on the anal funnel. In the plate the annelid with its tube of the natural size, two views (dorsal and ventral) of the cephalic lobe, and a figure of the posterior end of the body are given, besides four of the hooks magnified. The cephalic region is diagnostic, but the posterior end, or, as it is called, "Extrémité anale," represents only the ruptured constricted region between two preanal bristled segments, while the figure of the hooks is scarcely diagrammatic. The tube is evidently composed of sand-grains cemented to a lining of secretion.

Grube[1] (1851) doubtfully characterises the species as having a small anal funnel, and places it under the division of those with the plate of the head-lobe small. Sars, again, thought his *Clymene Mülleri*[2] somewhat approached this species, but there are decided differences. De Quatrefages[3] placed the species under his genus *Leiocephalus*, which he instituted for those with a head terminating in a papilla, and with no, or hardly any, cephalic plate. The anterior region of the body is stated to be composed of three elongate segments, the feet are biramous, the inferior division indistinct. He characterises the head as acute, protracted, with the cephalic lobe almost absent. The first segment, moreover, has no dorsal division. Kinberg[4] gives two foreign genera (*Chrysothemis* and *Sabaco*) with a comparatively simple anal funnel, but there is nothing else in their structure to associate them with the present species.

[1] 'Fam. Annel.,' p. 157.
[2] 'Ann. Nat. Hist.,' 1857, ser. 2, vol. xx, p. 156.
[3] 'Annelés,' ii, pp. 242—243.
[4] 'Œfversigt K. Vetensk.-Akad. Forh.,' 1866, pp. 340, 341.

Grube,[1] in his remarks on the group, pointed out that for a proper classification of the Maldanidæ both ends of the body are necessary, and therefore the precise position of Audouin and Milne Edwards' *Clymene ebiensis* is uncertain. He would in the meantime decline to place this species under the genus *Leiocephalus*, De Quatrefages, and thought that it perhaps was identical with *C. intermedia* (which the examination of a perfect specimen shows that it is not). He mentioned two species with smooth anal funnels, viz. *C. urceolata*, Leidy,[2] and *C. leiopygos*, Grube. The latter will be mentioned elsewhere; while the number of the segments, their condition as regards bristles, and the large urceolate anal funnel of the former leave doubts as to its identity with *C. ebiensis*, even with the necessary margin for imperfect description.

A specimen, incomplete posteriorly, and in its tube of coarse sand, was dredged by Dr. Gwyn Jeffreys in the Outer Haaf, Skerries, Shetland, in 1867, and was recognised by the pointed snout, the somewhat swollen anterior segments, and the absence of the usual frontal flattening, whilst the shape of the hooks was diagnostic.[3] It was at the same time stated that it was allied to Grube's *Clymene leiopygos* from Cherso, though, of course, this diagnosis rested on the characters of the anterior region only. The acquisition of a perfect specimen, however, shows that Grube's species differs in the number of bristled segments, which are twenty-three, as well as in the form of the anal cup and the preanal segments. The anal cup, moreover, follows the last bristled segment, and thus materially differs from the condition in *Clymene ebiensis*. It was subsequently procured in the 'Porcupine' Expedition of 1870 at 305 fathoms in the Atlantic, but in this specimen also the posterior region was absent. Hansen's *Clymene Koreni*,[4] another form with a smooth anal funnel, has only eighteen bristled segments, and the cephalic plate is like that in *Maldane:* whilst the *Nicomache McIntoshii* of Marenzeller[5] has a flattened and otherwise divergent funnel, though it is smooth.

Prof. Benham (1896) considers that *Clymene lumbricoides*, De Quatrefages, is fairly common, but there is ambiguity, for whilst he describes the British form as having an entire anal funnel and a laterally compressed prostomium, De Quatrefages states that the anal funnel has alternately large and small denticulations in *Clymene lumbricoides*. In all probability Prof. Benham refers to *Clymene ebiensis*.

So far as can be observed the *Leiochone clypeata* of De St. Joseph appears to be this species, for there is no point of difference except the presence of what he calls pennate forms amongst the shorter bristles anteriorly. He rightly expresses doubt as to the identity of Audouin and Milne Edwards' form, but on the whole it could not well be any other species. De St. Joseph thought Grube's *Clymene digitata* the same form. The hooks of De St. Joseph's form differ from the typical hook of *Leiochone ebiensis*, and more resemble that of *Leochone Johnstoni*, from Loch Alsh, but as the figure shows no downward curve posteriorly (the distal line being straight) some doubt remains as to its accuracy.

[1] 'Abh. Schles. Gesellsch. f. vat. Cult.,' 1867, p. 52, and 'Ann. Nat. Hist.,' 1868, ser. 4, vol. ii, p. 393.

[2] 'Marine Invert. Rhode Isl. and N. Jersey,' 1855, p. 145.

[3] 'Trans. Roy. Soc. Edinb.,' 1869, vol. xxv, p. 422.

[4] 'Norwegian N. Atlantic Exped.,' 1882, p. 40, pl. vi, figs. 1—5.

[5] 'Polychäten Angra Pequena-Bucht, Zool. Jahrbuch,' Bd. iii, p. 19, Taf. i, fig. 8.

2. Leiochone borealis, *Arwidsson*, 1906. Plate C, figs. 15, 15 *a*, 16 and 17—head and tail; Plate CVIII, figs. 5 and 5 *d* and var., fig. 6—bristles and hooks.

Specific characters.—Cephalic plate with a well-developed rim, the lateral slip being behind the middle. Nuchal grooves short. Eyes at the side of the median peak. Extruded proboscis with a bare belt between the basal and distal papillæ. The seventh bristled segment long with the feet anterior. The eighth shorter with the feet behind the middle. Nineteen bristle-bearing segments, and five naked segments posteriorly. Long, sometimes very long, thread-like anal cirri, the ventral the longest, and as a rule paired; longest over the anal opening; seven to nine or eleven cirri. Bristled segments six to nine with nephridia, their apertures about half the length of the hook-rows behind the feet. Two-thirds of the anterior of each bristled segment from the fourth to the seventh are glandular. At the eighth ventrally the anterior glandular area has lost its free glands anteriorly. The first bristled segment has both kinds of bristles. The hooks of segments 1 to 3 are mostly simple with two to six teeth above the main fang, and hairs on the throat appear in the third segment. When fully developed the hooks have seven teeth. The bristles posteriorly show narrow wings. Body 60 to 70 mm. in length. Colour reddish-brown anteriorly. The seventh segment has a blood-red band behind the feet (Arwidsson).

Tube free, fragile, cylindrical, composed of secretion externally with sand-grains, minute fragments of shells, and minute Foraminifera.

Synonyms.

1869. *Praxilla* sp., McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 421.
1872. ? *Clymene paucicirrata*, Sars. Forh. Vid.-Selsk. Christ. (1871), p. 252. Undescribed.
1906. *Leiochone borealis*, Arwidsson. Skandin. u. arktisch. Maldan., p. 156, Taf. iii, figs. 108—115, Taf. iv, figs. 116—117, Taf. ix, figs. 281—283, Taf. xi, figs. 352—353.
1908. „ „ Bidenkap. Zool. Anzeiger, Bd. xxxiii, p. 267.
1913. „ „ Nolte. Wiss. Meeresuntersuch., n.f., Bd. xv, p. 33, Taf. i, fig. 11, Taf. ii, fig. 31, text-figs. 8—10.

Habitat.—Dredged in 80 fathoms at the Outer Haaf, Skerries, June, 1867, by Dr. Gwyn Jeffreys. Extends also into the North Sea; St. Magnus Bay, 100 fathoms, 1867; 90 fathoms off North Unst, 1868; 'Porcupine,' 1870: 795 fathoms (17 *a*) and 358 fathoms, Station No. 8; Galway Bay. ?

It ranges to Norway.

A similar form occurs in Canadian waters, and another in Japanese seas.

The cephalic region (Plate C, fig. 15) ends anteriorly in a short, bluntly-conical peak. The rim is more largely developed than in *Praxillella prætermissa*, with a rather shallow lateral notch on each side, and a median posteriorly. The median ridge begins a little behind the middle and extends forward so as to embrace the peak, the whole thus having the outline of a spoon, a feature not alluded to by Arwidsson. The nuchal grooves begin about the middle of the head and diverge a little anteriorly. Eyes occur on each side of the anterior peak. The proboscis in extrusion presents a longitudinally furrowed basal

region. Then follows a densely papillose belt, the papillæ being in rows. The distal part is smooth.

The first two bristled segments are somewhat long, the succeeding being shorter, the rest a little longer. The eighth is short, and the feet are behind the middle; then follow eleven segments, of which the first and still more the last are short, the intermediate longer. There are, Arwidsson notes, five bare segments, the last three being very short, whilst the three anterior have rudiments of feet. The part in front of the anal cone is wider, with a prominent rim, from which the cirri project. There are nineteen bristle-bearing segments.

The longest anal cirrus is mid-ventral, and none occurs in the mid-dorsal line, but on each side is a short pair, then a longer pair, between which and the long median ventral are a shorter pair on each side. There may be from seven to eleven cirri. The anal cone (Plate C, fig. 15 *a*) is long, and the ventral ridge is distinct.

The nephridia occur from the sixth to the ninth bristled segments, and their external apertures are behind the hook-rows.

Integumentary glands are on the cephalic plate, and behind the mouth. The first bristled segment has rows of glands dorsally behind the feet, and they also occur ventrally. The next two have glands anteriorly, whilst the three following are more densely glandular. The seventh has glands anteriorly—chiefly in front of the feet. The eighth has a triangular glandular area ventrally in front, and the succeeding segments have glands dotted along the nerve area—these being especially distinct at the feet, where a ring of glands occurs in each segment. Indeed, glands appear as far as the anal cone.

The three anterior bristled segments have modified hooks, in which the gular bristles are absent, though the ridge of origin may be present. The bristles (Plate CVIII, figs. 5 and 5 *a*) anteriorly present a distinct wing, and at the second these are accompanied by spinous bristles (Plate CVIII, fig. 5 *c*). The posterior bristles are slender, winged forms, with long tips, the wings varying in breadth, and these bristles in the terminal segments are stouter.

The typical hook (Plate CVIII, figs. 5 *d* and 5 *e*) has a high crown and about seven teeth above the main fang.

Arwidsson found females with ripe eggs in May, June, and July.

Reproduction of lost parts, either anterior or posterior, occurs in this as in other Polychæts.

The tube is friable, apparently free, and is composed of fine sand, a little mud, and secretion. A few minute Foraminifera and sponge-spicules occur amongst the sand.

Leiochone borealis, var.

A form procured in the North Sea[1] slightly differs in the structure of the hooks, for only five teeth occur above the main fang (Plate CVIII, fig. 6). The rim of the cephalic plate was very faintly marked laterally, and the posterior margin was also shallow. A prolapse of the gut had taken place *per anum*, but the thread-like cirri occurred on the

[1] I am indebted to the courtesy of Prof. D'Arcy Thompson for an opportunity of making this note

margin of the funnel—the longest being ventral, and two shorter on each side, the mid-dorsal region being bare.

3. Leiochone Johnstoni,[1] n.s. Plate C, fig. 19—head; Plate CVIII, figs. 7 to 7 *c*—bristles and hooks.

Specific Characters.—Cephalic region devoid of a dorsal plate, as in *L. ebiensis*, the median ridge with the nuchal grooves running straight forward to a fillet on each side of the median frontal process, which is less acute than in the species named. A ridge on each side of the median converts the nuchal grooves into deep pits. Body 5 to 6 inches in length and robust. The first segment is short, those in the middle of the body are longer, but no specimen is complete. Bristle-tufts and ridges for hooks are conspicuous. Posteriorly four segments, counting the swollen ring, are naked, and the anal segment, narrower than that in front, has a mid-ventral cirrus longer than the others, and adjoining it are two or three shorter cirri on each side. About half the circumference of the ring is thus bare, the margin being finely crenate. Only a single segment intervenes between the last bristled segment and the anal rim. Bristles in two groups, a stronger-winged series, and a shorter, slender group, with hair-like tips. Hooks with remarkably broad crowns in proportion to the length of the neck, and the crown is flattened in side view and has more than seven teeth above the main fang, which has the gular bristles closely applied to its lower edge.

Tube composed of coarse sand, firm, but friable.

Habitat.—Dredged by Dr. Assheton in Loch Alsh and Loch Broom, September, 1911.

The cephalic region (Plate C, fig. 19) dorsally has no plate, only the median ridge with the deep nuchal grooves, and these run straight forward to a fillet (in the preparation) on each side of the base of the median frontal process which is less pointed than in *Clymene ebiensis*, in which also a ridge occurs on each side of the median one, so that the nuchal grooves lie in a deep pit which ends bluntly at the median frontal process. No eyes are visible. The body seems to be of considerable proportional size and probably attains a length of 5 or 6 inches, at least. The first segment is short, but those in the middle of the body are longer, though, as no specimen is complete, this is uncertain. Both bristle-tufts and hook-ridges are conspicuous.

Five segments posteriorly are devoid of bristles, and the anal ring, which is narrower than that in front, has a mid-ventral cirrus longer than the others, and adjoining it a pair of shorter cirri on each side. About half the circumference is thus smooth, or only with a finely crenate margin. In another example with a tail in process of reproduction there were three lateral cirri on each side of the longer mid-ventral, and it is interesting that only a single segment intervened between the anal rim and the last bristled segment. None of the cirri are long.

The bristles form two groups, a stronger series (Plate CVIII, fig. 7) with stout, striated shafts and distinct wings, and a more slender series (fig. 7 *a*) with long, hair-like tips, which have a distinct curve.

The hooks are remarkable for the great breadth of the crown (Plate CVIII, figs.

[1] Named after Dr. George Johnston, who was the pioneer of Annelidan work in Britain.

7 *d* and 7 *e*) in proportion to the length of the neck, and the shaft is also long and tapering, as well as curved like a bow. The transverse diameter of the crown from the tip of the main fang backward is only a little less than the entire length of the distal region from the shoulder upward, and the crown is more or less flattened. The main fang leaves the neck at a little more than a right angle, and the stiff gular bristles are closely applied to its lower outline, and then curve like a crest over it. There are more than seven teeth above the main fang, and bold striæ pass from these and the great fang down the neck and join those in the shaft. Moreover, the second quarter, or sometimes the middle third, of the shaft is marked by slightly oblique striæ.

It was at first thought that this was a large variety of *Leiochone ebiensis*, but the structure of the cephalic region, that of the anal funnel with its cirri, and the structure of the hooks warranted separation in the meantime. The specimens were kindly forwarded by Dr. Assheton, who procured them during a dredging expedition in Scotland.

The hooks differ from those of *Leiochone polaris* of Théel,[1] since that form has only three teeth on the crown behind the great fang, and a space occurs between the gular bristles and the base of the fang. Moreover, in *L. polaris* only a single cirrus occurs on the anal rim.

4. Leiochone clypeata, *De St. Joseph*, 1894. Plate CIX, figs 11 and 11 *a*—bristle and hook.

Specific Characters.—Cephalic plate nearly transversely truncated, only a slight inclination downward and forward being noticeable. Outline somewhat ovoid, and the erect rim is not much developed and has a shallow excavation in place of the lateral notch on each side. A short, bluntly-conical median frontal process is continuous with the narrow keel, which extends nearly to the posterior border. Nuchal grooves appear to commence near the posterior end of the keel and diverge as they pass to the anterior border on each side of the frontal process. Body nearly cylindrical behind the cephalic region, but diminishes toward the caudal funnel. The anterior segments are richly supplied with glandular belts and patches, but the posterior are more translucent, though glands are also present at the rows of hooks. The ventral streak is faint so that posteriorly the dorsal and the ventral surfaces are not readily distinguished. This (posterior) region has a moniliform series of about nine narrow, bristled segments, which are urn-shaped. Two unarmed rings follow with the funnel, which externally is shaped like a dice-box, with six equal, moderately long, subulate cirri and a slightly longer seventh in the mid-ventral line. Anus in the centre of the terminal cup, without an anal cone.

Bristles in two groups; stronger pale yellow forms nearly straight and with tapered tips and wings, and slender translucent bristles with very fine hair-like bristles and spinous edges. The first three segments have spines, the shafts of which are slightly curved in the third foot and have bluntly-conical points. Modified hooks without gular bristles occur on the fourth segment. The typical hook is rather short, with curved shaft, somewhat short neck, broad toward the tip, and curved backward, the main fang making less than a right angle with the neck, and having gular bristles immediately beneath. About seven teeth occupy the high crown behind the great fang.

[1] 'Kongl. svenska Vet.-Akad. Handl.,' Bd. xvi, p. 58, pl. iv, fig. 56.

Tube free, fragile, cylindrical, composed internally of secretion, and externally of adherent sand-grains, minute fragments of shells, and a few Foraminifera.

Synonyms.

1879. *Praxilla polaris,* Théel. Annel. Nouv.-Zemb., p. 58, figs. 55—56.
1884. *Clymene* ,, Levinsen. Nord. Annel., p. 143.
1898. *Leiochone clypeata,* Orlandi. Atti Soc. Ligust. Sc. nat., vol. ix, p. 18.
1900. *Clymenella* (*Axiothella*) *polaris,* Verrill. Trans. Conn. Acad. Arts Sc., vol. x, p. 2.
1906. *Leiochone polaris,* Arwidsson. Skand. u. arktisch. Maldan., p. 150, Taf. iv, figs. 118—123, Taf. ix, figs. 284—287.
,, ,, *clypeata,* Bohn. Ann. Sc. nat., sér. 9, t. iii, p. 113 (movements).
1909. ,, ,, Lo Bianco. Mitt. Zool. Stat. Neapel, Bd. 19, p. 581.
1910. ,, *polaris,* Elwes. Journ. M. B. A., vol. ix, p. 64.
1913. ,, *clypeata*, McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 98.

Habitat.—Dredged in 100 fathoms, St. Magnus Bay, Shetland, by Dr. Gwyn Jeffreys in 1867; common at Torquay (Elwes).

The anterior end is characterised by the stiff, almost transversely truncate, condition of the cephalic plate, only a very slight inclination downward and forward being noticeable. The surface of the plate is somewhat ovoid, and the rim is slightly developed, being erect all round, and with a shallow excavation in the place of the lateral notch on each side. A short, bluntly-conical, median, frontal process is continuous with the keel—a narrow ridge which passes backward nearly to the posterior border. The nuchal grooves appear to commence near the posterior end of the keel, and diverge a little as they run to the anterior border, debouching on each side of the median frontal process and at a greater distance from each other than usual, indeed, that on the right side cuts off a special section of the rim. Viewed antero-posteriorly the cephalic region is narrower than the second or buccal part, and in lateral view the same condition exists, for the mouth is prominent, three folds characterising the outline behind the median frontal process.

The body is nearly cylindrical behind the cephalic plate (having been preserved in its tube) with the exception of the slight posterior diminution toward the caudal funnel. Nineteen bristled segments appear to be present and apparently only one unarmed ring posteriorly. The anterior eight are richly supplied with glands, those following, especially the posterior ten, being less so, the wall being more or less translucent. The median ventral streak is faintly indicated; indeed, in the posterior fragment it is not easy to distinguish the dorsal from the ventral surface at first sight, though on subsequent minute inspection, a slight ridge is seen on the ventral aspect of the funnel. The most characteristic feature about the body is the flattened moniliform condition of the last nine bristled segments, which are narrow and vase-shaped, the wide end being posterior. So far as observed no other British Maldanid presents a similar conformation. Behind the foregoing are two rings, the funnel arising with a broad base from the second, and showing a slight constriction before reaching the rim, thus giving the outline of a dice-box to the funnel. Six of the subulate cirri of the funnel are alike and moderately long, the seventh or mid-ventral being a very little longer. Though externally the caudal funnel seems to be long, the anal aperture is in the centre of a shallow distal cup, and has no cone.

The bristles are in two groups, pale yellow stronger forms nearly straight and with

tapered tips and wings (Plate CIX, fig. 11), and smooth slender bristles with very attenuate tips. The first three segments have rather long spines, slightly curved, striated organs with a conical tip, which may have a slight constriction below it. The fourth foot has a row of hooks with somewhat long, curved shafts, a bold shoulder, and beyond is the constriction of the short neck which curves backward and enlarges to the crown. The main fang leaves the neck at a little less than a right angle, and four teeth at least occur on the crown behind it, though it has not yet reached full height. There are no gular bristles. The neck is obliquely and boldly striated, and an opaque region of the shaft behind the shoulder is probably likewise striated.

The typical hook is characterised by its comparatively short, curved shaft, high crown, and the broad, strongly striated distal region with the teeth (Plate CIX, fig. 11 *a*). The opacity behind the shoulder shows faint striæ. The main fang leaves the neck at considerably less than a right angle, and from the neck immediately below its base is a tuft of gular bristles which pass to the tip and bend upward on each side of the fang. The crown is now high, and there are seven teeth above the great fang. The lower and the central regions of the neck are strongly striated.[1]

The tube is fragile, the lining being composed of a thin layer of secretion to which sand-grains, minute fragments of shells, and Foraminifera are attached externally.

There are points of difference between this form and the typical *L. polaris*, such as the length of the nuchal grooves, but the hook is nearer it than any other form. Further work in the Maldanids may considerably modify published views.

A very similar form was dredged by Dr. Gwyn Jeffreys in 90 fathoms off North Unst, on July 15th, 1868. If the specimen, which is larger, is completed by the two fragments in the bottle, and they so far agree, the number of segments would then be twenty-three, a larger number than usual in the group. The funnel has fourteen cirri, that over the ventral ridge being only a little longer and broader than the others. As they are set on the rim at intervals their arrangement is characteristic. The hooks and bristles seem to correspond with the foregoing. A high power does not show fine spikes on the delicate hair-like tips, but the specimens had long been preserved. The tube in this case is composed of somewhat coarse fragments of shells, fragment of the tube of *Ditrypa*, and sand-grains attached to the secretion.

Genus CXXII. Praxillella, *Verrill*, 1882.

Nuchal grooves long; conspicuous cephalic rim with notches posteriorly. Glands between them. Proboscis with papillæ at the base. Anterior feet of the eighth bristled segment behind its middle. Long, naked segments posteriorly, and a short grooved ring before the anal cup. Anal cirri distinct, small, with a longer ventral cirrus. Anal cone pointing to the anal cirrus. The cephalic plate with glands chiefly between the nuchal organs. Hooks of segments one to three more or less variable, with long shafts and hairs on the throat under the main fang and extending at its sides. Anterior bristles with

[1] Arwidsson also describes a *Leiochone* to which he gives no name in 'Proc. Roy. Irish Acad.,' vol. xxix, p. 214, 1911.

slight wings, and some with hair-pencils at the tip. The posterior bristles have narrow wings and no hair-pencils. Tube free and straight, somewhat thin.

1. Praxillella affinis, *Sars*, 1871. Plate CVIII, fig. 8—hook.

Specific Characters.—The central peak of the cephalic region is not elongated. The cephalic rim has no central notch. The nuchal organ is long. Eyes present. The papillæ of the proboscis are reniform, and there are nine or ten in each row. Eighteen bristled segments and three naked segments posteriorly. The posterior segments follow evenly to the anal ring. Nephridia in bristled segments 6 to 9. The body has marked glandular belts from the third to the eighth bristled segment. Rudimentary hooks in segments 1 to 3. Hooks have seven teeth above the great fang. The posterior bristles of the tenth and eleventh segments have a broad and fine hair-pencil. Tube free.

The nearest approach to the *Praxillella affinis* of Sars is made by a form dredged in St. Magnus Bay by Dr. Gwyn Jeffreys and Canon A. M. Norman in 1867, in which the cephalic lobe is rather full, with slight lateral and posterior notches, though in some these can scarcely be noticed. The cephalic ridge is long, and the nuchal grooves do not widen out anteriorly. The proboscis is smooth, and thus it differs from *Praxillella.* The body tapers toward the tail, where at least three naked segments occur, the last having a slight constriction behind the anal ring, which carries a series of short cirri apparently of nearly equal length, whilst the anal cone is long and conical like that of *Praxillella gracilis.*

The bristles consist mainly of those with stout shafts and long, tapering, winged tips, and a few very slender forms with finely attenuate tips.

The hooks (Plate CVIII, fig. 8) somewhat resemble those of *P. prætermissa*, though the main fang is somewhat shorter and the crown rather more elevated. Six teeth occur above the main fang. The gular bristles arise close beneath the fang and curve upward above it.

The tube is straight, composed of sand and secretion, and is friable.

Synonyms.

1871. *Clymene affinis,* Sars. Christ. Vid.-Selsk. Forh., p. 412.
1883. „ „ Levinsen. Vidensk. Meddel. Nat. For., p. 144.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forh., p. 113.
1911. *Praxillella affinis,* Arwidsson. Proc. Roy. Irish Acad., vol. xxix, p. 215.
1912. *Clymene affinis,* Ditlevsen. Danmark-Eksped. Grönl., Bd. v, p. 427.
1913. *Praxillella affinis,* McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 100.

Habitat.—South coast of Ireland, Station R 31 (8, p. 27), or 6 miles S.E.S. of Mine Head, 53 m. (Arwidsson).

In one three to eight setigerous segments, and in the other three to seventeen. "Besides, there is a posterior extremity possibly belonging to one of the foregoing." "Amongst other things are found the specially developed setæ on the tenth and the eleventh setigerous segments" (Arwidsson).[1]

[1] 'Proc. Roy. Irish Acad.,' 1911, vol. xxix, p. 215.

2. Praxillella gracilis, *Sars*, 1861. Plate CI, figs. 5 and 5 *a*—head and tail; Plate CIX, figs. 12 and 12 *a*—bristle and hook.

Specific Characters.—The anterior border of the head produced into a filiform process projecting from the conical base. The margin of the cephalic plate, which slopes somewhat more obliquely downward and forward than in *P. prætermissa*, extended into a broad flap, especially antero-laterally. The narrow median keel stretches far backward; the nuchal organs are long, the anterior end bending outward. The papillæ of the proboscis are conical, large, and there are nine to ten in each row. Body is constricted anteriorly, rounded dorsally, slightly flattened and grooved ventrally; nineteen bristled segments, and four without bristles posteriorly. Anal funnel with a long ventral cirrus and about twenty-five small cirri. Segmental organs in bristled segments 6 to 9.

Bristles of two kinds—strong bristles having straight shafts and slightly curved tips with narrow wings, and more slender translucent forms with just a trace of wings.

The hooks have rather long, curved shafts with a distinct shoulder, somewhat short neck, which increases in breadth distally, the main fang coming off nearly at a right angle with the gular bristles close to its base, and five or six teeth on the crown behind it.

Somewhat soft tube of mud and sand lined by a translucent amorphous secretion.

Synonyms.

1856.?	*Clymene quadrilobata,*	Sars.	Fauna Lit. Norv., ii, p. 5, Tab. 2, figs. 18—22.
1861.	„	*gracilis,* idem.	Christ. Vid.-Selsk. Forh., p. 91 (sep. copy), p. 22.
„	„	„	Sars. Nyt Mag. f. Naturvid., xi, p. 256.
1865.	„	„	De Quatrefages. Annel., t. ii, p. 657.
„	*Praxilla*	„	Malmgren. Nord. Hafs-Annul, p. 192.
1867.	„	„	idem. Annul. Polych., p. 100, Tab. xi, fig. 63.
1869.	„	„	McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 421.
1875.	„	„	Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 26.
1879.	„	„	Tauber. Annul. Danica, p. 125.
1882.	*Praxillella*	„	Verrill. Trans. Conn. Acad. Arts Sc., vol. iv, p. 298.
1883.	*Clymene*	„	Levinsen. Vidensk. Meddel. Nat. For., p. 144.
1894.	„	„	Bidenkap. Christ. Vid.-Selsk. Forh., p. 114.
1900.	*Encylmene*	„	Verrill. Trans. Conn. Acad. Arts Sc., vol. x, p. 665.
1902.	*Clymene*	„	Marenzeller. Denkschr. Math. Nat. Cl. k. Acad. wiss. Wien, Bd. 74, p. 21.
1906.	*Praxillella*	„	Arwidsson. Skand. u. arktisch. Maldan., p. 183, Taf. iv, figs. 153—155, Taf. v, figs. 156—158, Taf. ix, figs. 302—307, Taf. xii, fig. 367.
„	*Praxilla*	„	Augener. Westind. Polych., p. 162.
1909.	*Praxillella*	„	Percy Moore. Proc. U. S. Nat. Mus., vol. xxxvii, p. 142.
1913.	„	„	McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, pp. 100, 115, 119, 124.
„	„	„	var. *borealis,* Nolte. Wiss. Meeresuntersuch., N.F., Bd. xv, p. 38, Taf. i, figs. 12, 13, Taf. ii, fig. 32, text-fig. 11.

Habitat.—Fragmentary small examples were dredged in 100 fathoms in St. Magnus Bay, Shetland, 1867 (J. G. Jeffreys).

In the 'Porcupine' Expedition of 1870 it occurred in 81 fathoms off Cape Finisterre.

It ranges to the Gulf of St. Lawrence, Canada (coll. Dr. Whiteaves); Norway and Finmark (Malmgren); Spitzbergen, East and West Greenland (Arwidsson); Norway (Sars); United States of America, New England (Verrill); North Sea (Ehlers); West Indies (Augener); N. E. America (Moore).

The *head* (Plate C, fig. 5) has the cephalic plate somewhat more oblique than in *P. prætermissa*, so that the anterior border is more acute in lateral view, especially as the filament and anterior process thus appear as a continuous narrow appendix. In the median line anteriorly is the flattened conical prow seen in the form above mentioned, but it has distally the filiform process so characteristic of the species. From the basal process the long and rather narrow glandular keel passes backward almost to the posterior border. The long nuchal organs lie at each side, and they slightly bend outward anteriorly, but do not reach the margin which has two broad lateral flaps in front of the notches, and a narrower and often more or less erect border behind the notches. The fused pro- and peristomial segments have the large aperture of the mouth ventrally, and it is usually marked by a series of radiating furrows which are somewhat regularly arranged on the prominent posterior lip. Anteriorly a ridge runs forward to the notch on each side of the flattened base of the anterior process. In partial protrusion the proboscis forms a button-shaped papillose organ, but in full extrusion a considerable bladder-like, smooth region with a terminal fissure occurs beyond it. The papillæ on the basal region in extrusion are bluntly conical, large and prominent; four to five papillæ being in each row anteriorly, and nine or ten occurring, as Arwidsson observes, in each row posteriorly. Reddish mud oozed from the mouth on the slightest pressure. The fine mud swallowed by the annelid contains many organic elements besides spicules of sponges and minute sand-grains. An occasional larval annelid is met with in it.

The *body* is more or less rounded dorsally, slightly flattened behind the anterior third ventrally, and marked by a median streak, which becomes a ridge posteriorly. A distinct constriction behind the cephalic region affecting three or four segments occurs anteriorly. There are nineteen bristled segments, and four without bristles posteriorly. Large forms exceed 100 mm. in length, and the walls of the body posteriorly are thinner than in *P. prætermissa*, so that from flattening the diameter in large examples is 4 to 5 mm. The anal funnel (Plate CI, fig. 5 *a*) is comparatively small, has a prominent anal cone with a valve, a long ventral cirrus, and twenty-two to twenty-five (Arwidsson gives twenty-seven) shorter cirri, which vary in length in different specimens. Pigment is usually absent in spirit-specimens, but in one the anterior region is mottled with brownish-red. The anterior bristled segments from the first to the eighth are glandular, but the glandular elevations at the rows of hooks thereafter are absent. Arwidsson gives in detail the arrangement of the glands in the various parts. The segmental organs occur in bristled segments 6 to 9. The first, second, and third segments are, as mentioned, firm, rounded and glandular, the ventral streak forming a ridge rather than a groove. Each has a short row of hooks and a tuft of rather long bristles (Plate CIX, fig. 12), which are in two groups, a stronger golden series with nearly cylindrical shafts, except the somewhat narrowed region at the base, and tapering and slightly curved tips with narrow wings, and a more delicate series having slender tips with a trace of wings. The hooks of the three segments differ from the succeeding in the absence of the gular bristles, in the great size

of the main fang, and in the rudimentary condition of the spikes on the crown; all these features with the comparatively narrow distal region being conspicuous in those of the first bristled segment (Plate CIX, fig. 12 *a*). The main fang leaves the neck at more than a right angle and its distal outline is sinuous so as to resemble a foot; further a slight swelling occurs on the throat at its base. In these segments (three anterior) the bristles and hooks are in front of the boundary of the anterior third, and lateral in position. The fourth segment is equally glandular, though short, and its row of hooks is longer. The shafts of the hooks still retain their great length and curvature, increasing in size from the somewhat slender basal region to the broad shoulder, then contracting at the neck, which slightly widens in its passage forward to the crown. The main fang comes off more nearly at a right angle than in the anterior feet, is proportionally less, is evenly curved on its distal margin, and has four teeth on the crown above it. Moreover, the gular bristles spring from the throat immediately beneath the great fang, curve forward to its tip, and

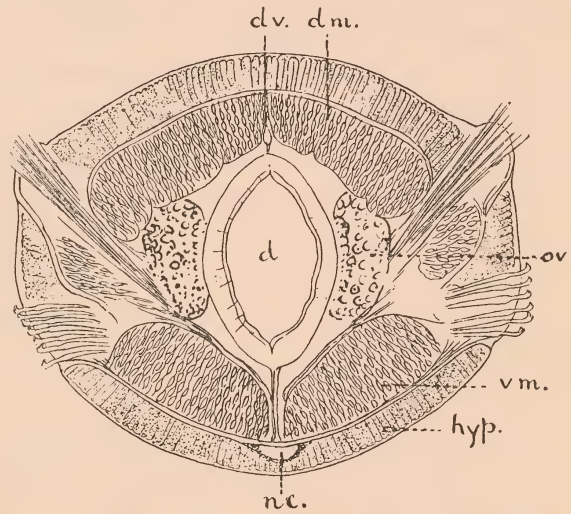

Fig. 134.—Transverse section of *Praxillella gracilis*. *ov*. Ova. *hyp*. Hypoderm.

bend upward above it. The distal region has straight striæ superficially at the end, oblique striæ in the deeper part of the neck, and the shaft is longitudinally striated. The hooks remain for the most part similar in the fifth, sixth, and seventh segments, except that in some a tendency to differentiation of the crown with its four smaller teeth and the trend of the posterior outline is observed. The typical hook shows a narrower neck above the prominent shoulder, a shorter distal region or neck, which is broad at the crown and has at least five (six, Arwidsson) teeth above the main fang, but the gular bristles retain their position close to the base of the great fang, and without differentiation of the outline. The hooks of the small form from St. Magnus Bay have a higher crown than those from Canada.

The posterior hooks, for instance those of the last row, differ chiefly in their smaller size, the shafts being shorter, the smaller main fang, and the more prominent condition of the crown with the smaller teeth, four of which are evident as in front. The gular bristles have the same arrangement. The bristles of this region retain the structure of those in front. As a rule the number of the hooks increases at the fourth segment, and at the sixteenth there may be sixteen or seventeen in each row (Arwidsson). The same

author found in an example from Lofoten the tips of the posterior (tenth) bristles feathered with fine lateral fibres, a condition not yet observed here. He also met with one reproducing the terminal segments without bristles.

In transverse section (Fig. 134) the development of the hypoderm is noteworthy, and between the bristles and hooks a special longitudinal muscular slip is present. The disproportion between the dorsal and ventral longitudinal muscles is less than in *Nicomache maculata*, but the nerve-cords are similar. A large ovisac occurs in the female on each side.

The tube consists of mud and sand-grains round a lining of amorphous secretion, and is free. It readily yields to pressure applied externally. Occasionally the translucent secretion projects beyond the external coating of mud and sand.

Reproduction.—Arwidsson observed, in a large individual from West Greenland in August, the male elements developing, whereas in another from Lofoten in March these elements were minute.

In a large female from the Gulf of St. Lawrence (35 and 36, 1873) the cœlomic cavity is filled with fluid containing many ova—some fairly advanced.

3. Praxillella præternissa, *Malmgren*, 1866. Plate C, fig. 21—tail; Plate CIX, figs. 13—13 *c*—bristles and hooks.

Specific Characters.—The anterior border of the head-plate not produced into a finger-like process. Posteriorly the border is notched. Nuchal organ fairly developed. The papillæ of the proboscis kidney-shaped, eight to nine in each row. Nineteen bristled and four unarmed segments posteriorly. The anal cup has a narrow stem coming from the third naked segment; anal funnel with twenty-two to twenty-three cirri. Segmental organs in bristled segments 6 to 9 (Arwidsson). Bristled segments 1 to 8 have glands anteriorly, large in second, and conspicuous from 5 to 8, where the feet are less. Glands are continued to the posterior end. Reduced hooks in segments 1 to 3. Segments as a rule have bristles. The hooks have gular bristles parted on each side of the main fang, teeth six to seven. Posterior bristles with broad wings; no distal hair-pencil.

Tube as a rule free.

Synonyms.

1865.	*Praxilla prætermissa,*	Malmgren.	Nord. Hafs. Annul., p. 191.
1867.	„ „	idem.	Annul. Polych., p. 100, Tab. xi, fig. 62.
1868.	*Clymene* „	Sars.	Christ. Vid.-Selsk. Forh., p. 10 (sep. copy).
1869.	*Praxilla* „	McIntosh.	Trans. Roy. Soc. Edinb., vol. xxv, p. 421.
1874.	„ „	idem.	Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875.	„ „	idem.	Invert. and Fishes St. Andrews, p. 128.
„	„ „	Ehlers.	Zeitschr. f. wiss. Zool., Bd. xxv, p. 26.
1879.	„ „	Tauber.	Annul. Danica, p. 124.
„	„ „	Théel.	Kongl. svenska Vet.-Akad. Handl., Bd. 16, p. 57.
1883.	„ „	Wirén.	Chætop. 'Vega' Exped., p. 411.

1883. *Clymene prætermissa,* Levinsen. Vidensk. Meddel. Nat. For., p. 144.
1885. *Praxilla* „ Carus. Fauna Medit., p. 252.
1886. *Clymene* „ Levinsen. Kara-Havets, etc., p. 10.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forh., p. 113.
1904. *Praxillella* „ var. *capensis,* McIntosh. Marine Invert. S. Africa, vol. iii, p. 75.
1906. *Praxilla* „ Augener. Westind. Polych., p. 162.
„ *Praxillella* „ Arwidsson. Skand. u. arktisch. Maldan., p. 192, Taf. iv, figs. 136 *a*—143, Taf. ix, figs. 294—296, Taf. xii, figs. 361—363.
1909. „ „ Fauvel. Bull. Inst. Ocean., 142, p. 11.
„ „ „ Moore. Proc. U. S. Nat. Mus., vol. 37, p. 142.
1913. *Clymene* „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, pp. 103, 113, 119, 128.
„ „ „ var., idem. Ibid., p. 116.
„ *Praxillella* „ Nolte. Wiss. Meeresuntersuch., N.F., Bd. xv, p. 43, Taf. 1, figs. 14—16.

Habitat.—Off the Hebrides in 1866; Outer Haaf, Skerries, in 70 to 80 fathoms; St. Magnus Bay, 100 fathoms; 30 miles west of the Blasquet, S.W. Ireland; 90 fathoms off North Unst (J. G. Jeffreys); dredged in Ardmaddy Bay, Lochmaddy, 1865 (W. C. M.); off St. Andrews Bay (E. M.).

Abroad it was procured by the 'Porcupine' Expedition of 1869 in 358 fathoms at Station 8, and at 17 *a* 9 miles off Cape Finisterre; and in 1870 at various stations, *e. g.* off Cape Guardia. It abounds on a bottom composed of reddish sand in the Gulf of St. Lawrence, Canada (coll. Dr. Whiteaves); shores of Norway, Sweden and Finmark (Malmgren); Nova Zembla, Spitzbergen, Greenland (Arwidsson); South Africa (W. C. M.); Marseilles (Marion); Siberian and Behring Seas (Wirén); 300 fathoms off Norway (Sars); Atlantic coast, U.S.A. (Verrill); Kara-Havets (Levinsen); West Indies (Augener).

The cephalic plate is sloped from above downward and forward, and has a median ridge from its posterior to its anterior border, where it ends in a flattened conical process which curves forward and slightly upward. The rim of the plate has a median notch posteriorly, a deep lateral notch a little more than a third of the distance forward, whilst its edge is rounded off on each side of the anterior median process. The rim in small examples has an entire margin throughout, but in large forms a series of notches, about five in number on each side, cut the border between the lateral notch and the median posterior into serrations. The deep part of the rim is the anterior section on each side. The nuchal grooves occur on each side of the median ridge—widening a little in their passage forward as they run into the notch or angle at the base of the median process. The mouth opens as a transverse slit on the ventral surface a little behind the median process of the cephalic plate, and occasionally the proboscis is extruded as a flattened button covered with small reniform papillæ, or in full extrusion as an ovoid sac or bladder.

The *body* is of moderate length, more or less rounded throughout, thicker in front and diminished toward the anal funnel, the posterior region, moreover, being for nine or ten segments moniliform. A median streak marks the ventral surface, which, further, is in parts somewhat less rounded than the dorsal. There are nineteen bristled segments, and four without bristles posteriorly.

The fused pro- and peristomium form a thickened mass—broad in front and con-

stricted behind where it joins the first bristled segment. The first three bristled segments are nearly equal in length, the first being the shortest in the preparations, and each bears a tuft of bristles and a golden spine, which in large examples is very powerful, though not long. It has a stout, striated shaft, enlarges from a slightly narrowed base, and again diminishes to the tip, which is likewise finely striated (longitudinally) internally, and often has a distinct curvature at the tip.

The first three bristled segments do not present marked glandular areas, but the fourth has a narrow ring at the anterior part of the segment, and in front of the bristle-bundles. The fifth, sixth, seventh, and eighth segments have broader belts of glandular tissue, which occur in the same part of the segment and envelope the ridges for the hooks. The ninth foot occurs at the posterior part of the segment, and is glandular, as are those which follow—as far as the nineteenth. The four terminal segments have a glandular ridge on each side, the last forming, by nearly coalescing with its neighbour, a kind of ring.

The six segments in front of the terminal funnel differ in shape from the preceding, being narrow in front and wider posteriorly, the elevation for the hooks or the corresponding glandular areas without hooks being placed on the prominent angles posteriorly. The seventeenth and eighteenth bristled segments, that is, the first two of this series, are, as a rule, those best marked, though the condition varies in the preserved examples. The bristles of these segments (Plate CIX, figs. 13 and 13 *a*) are in two groups, the larger being capillary bristles with fairly stout shafts and somewhat narrow wings at the finely attenuate tip. The other group consists of capillary bristles with more slender shafts and more finely attenuate tips. In the example from St. Magnus Bay the last tuft of bristles in front of the funnel had a mere trace of a wing, with the edge faintly serrated.

The anal funnel (Plate C, fig. 21) appears to vary considerably in regard to the number and the shape of the cirri, those with few cirri having them broad at the base and more distinctly conical, whilst they are more filiform in those in which the cirri approach thirty in number, though in one from North Unst the sixteen separate cirri are filiform. The elongated cirrus is in the mid-ventral line. The anal cup is comparatively shallow, with the anus often on a slight cone in the centre. In two large Hebridean examples the cirri of the funnel are all short, and twenty-seven in number. In another large form procured in the 'Porcupine' off Cape Guardia the funnel has no long cirrus; the number of cirri is thirty-seven, and the anal process is conspicuously ridged or folded. A small specimen from St. Magnus Bay (100 fathoms) had a very long, filiform, mid-ventral cirrus. Occasionally the vent projects as a conical process, similar to what Arwidsson shows in his *P. affinis*.

The hooks (Plate CIX, fig. 13 *b*) have a long, curved shaft, tapered at its base and dilating as it passes upward to the shoulder, which forms a prominent hump posteriorly and a slight one anteriorly. It then contracts to the neck, above which the distal region dilates, and ends in a broad, heavily-armed crown. The main fang leaves the throat nearly at a right angle, curves slightly downward, and ends in a sharp point. Six to seven teeth in a diminishing series occur on the crown. The interior of the shaft is striated, and the striæ are continued into the neck, where they are somewhat oblique inferiorly, but longitudinal toward the crown. The gular bristles come off close to the main fang, and curve forward and upward on each side of it. The anterior

hooks differ from the typical forms in their shorter and less-boldly-curved shafts, shorter necks, which are less dilated distally, in the larger angle made by the main fang and the neck, and in their much flatter crowns, three or four teeth only being visible behind the great fang; and the gular bristles are rudimentary, passing obliquely upward close to the main fang. The first hook of the row in the third foot is even more rudimentary, as shown by the blunt tip of the large fang, the fusion and indistinctness of the teeth on the crown, and its short and nearly straight shaft. Such may, however, be an undeveloped or developing form. The hooks of the last row (nineteenth row, Plate CIX, fig. 13 *c*) retain much of the typical structure, though their shafts are shorter. Five or six teeth are visible on the crown above the main fang, and the shoulder is largely developed. The bristles of this region consist of the two groups, the stronger having narrow wings, and the slender forms are few in number and extremely attenuate.

A large, though softened and fragmentary example, dredged by Dr. Gwyn Jeffreys off the Hebrides in 1866, has hooks which differ from the foregoing, not only by their great size, but in the presence of a distinct ridge or process for the gular bristles. There are twenty-seven short cirri on the funnel, but no longer process, though one is double. The same condition is seen in certain forms dredged at Nos. 35 and 36 and in 125 fathoms off Cape Rosier, Canada, in 1873. Further investigation of these is necessary, as they may pertain to other species.

A large example from the Outer Haaf, Skerries, Shetland, had the rim of the cephalic plate less developed and the antero-lateral margins slightly crenate, but otherwise it does not seem to differ. A specimen of medium size, again, from a depth of 90 fathoms off North Unst, presented a very long process for the dorsal bristles in several of the posterior segments (even to the third from the anal funnel), so that the feet at first sight appeared to have a short cirrus.

The tubes are composed of sand, with a lining of tough secretion. They are comparatively soft, though in small specimens from the Outer Haaf, Skerries, the minute grains of sand and shells cling tenaciously to the lining. Fragments of shells and of tubes of *Ditrypa* are attached to some tubes procured in the same region.

Regeneration of lost parts readily occurs. Thus, where severance of the body at the seventh bristled segment had taken place in an example from the Outer Haaf, Skerries, the anterior end forms a smoothly-rounded surface between the ridges for the hooks, whilst the ventral median line is elevated into a keel which extended along the posterior half of the segment.

Fauvel (1909) regards *P. arctica* as a synonym of this species.

In certain varieties of *Praxillella prætermissa* the anal ring bears longer and narrower cirri, such as Arwidsson shows in *P. affinis*, yet the hooks and other parts remain typical.

4. Praxillella (?). No gular bristles.

Dredged in the 'Porcupine' Expedition of 1870; locality not stated. Two segments from the middle of a fairly large species, in which both the bristles and the hook-rows are conspicuous. The bristles are long, strong, and golden, striated longitudinally, and with a distinct but narrow wing at the slightly curved and finely

tapered tip. A few slender, hair-like forms occur at the base, and represent the second group. The hooks (Plate CVIII, figs. 9 and 11) somewhat resemble those of *Praxillella prætermissa*, but the crown is more elevated and the great fang is shorter, whilst all that represents the gular bristles is in some a short process beneath the great fang, which does not reach its tip. As a rule, six teeth occur above the great fang. Another peculiarity is the absence of striæ in the anterior region of the neck down to the shoulder.

5. Praxillella V.

A form dredged off Cape Guardia in the 'Porcupine' Expedition of 1870 is characterised by the peculiarly notched cephalic rim (Plate C, fig. 20). In lateral view a large flap occurs in front, separated posteriorly by a notch from the posterior half, which is composed of three smaller segments and a larger posterior one, the hind edge of which abuts on the deep and broad median posterior notch. On the other side (left) the hind segment of the rim is larger, so that only two smaller ones occur between it and the edge of the long anterior division. A short, conical peak is present anteriorly in the middle line, and in front view the large anterior flaps or lamellæ of the rim are prominent, more so than in the *Praxillella prætermissa*. The cephalic plate has a median ridge and nuchal grooves like those of *P. prætermissa*. Bold anterior belts of glands are present, the first distinct one being that (a narrow one) between the third and fourth bristled segments. Broader belts are at the anterior border of the fifth, sixth, seventh, and eighth segments. The hooks somewhat resemble those of *P. prætermissa*, but the crown appears to be higher, five teeth occurring above the large fang. The gular bristles spring close to the latter and pass on each side of it. They are proportionally short.

Arwidsson arranges the Axiothella group according to the condition of the skin-glands, the presence or absence of a ring next the anal cup, the presence of a collar, the nature of the anal cirri, and the hooks in the anterior segments. His genera are *Axiothella*, *Clymenella*, and *Euclymene*. The following genus differs in certain respects, but may for the present be placed with these.

Genus CXXIII.—Arwidssonia, *n. g.*

Cephalic shield rounded, concave, with wide and thin margin; a minute median frontal process. Postero-lateral region of the margin notched. Keel arises from a rounded area a little behind the middle of the plate, posterior to nuchal grooves. Proboscis with long conical papillæ. Four unarmed segments posteriorly. Caudal funnel a fluted vase with numerous cirri, which are alternately long and short. Anal cone in centre. First three bristled segments have bristles and spines. Hooks with high crowns. Tube free, of fragments of various kinds of sand, and shell-fragments.

1. Arwidssonia zetlandica, *McIntosh*, 1913. Plate XCIX, figs. 6 to 6*f*—head and tail; Plate CX, figs. 5 to 5*d*—bristles, spines, and hook.

Specific Characters.—Outline of cephalic shield rounded rather than ovoid, concave rather than convex, with a remarkably wide and rather thin margin, and a minute central

frontal process from which the broad antero-lateral flaps pass backward to the pronounced notch, which is confined to the outer half of the flap. Postero-lateral margin behind the notches has six larger marginal crenations, each subdivided into two, three, or four minor ones. The very narrow keel arises from the anterior edge of a rounded area a little behind the middle, and posterior to two nearly transverse grooves. It widens as it approaches the median frontal process, and again contracts as it joins it. From each side of the keel posteriorly springs a narrow ridge which ceases at the enlargement of the keel in front. A deep groove (nuchal groove) lies between the keel and the ridge, and another less pronounced exterior to the ridge. The former debouches on each side of the minute frontal process. Proboscis a globular, grooved mass, with rows of rather long, conical papillæ. Body narrowed behind the anterior end, and again increasing toward the eighth segment. Ventral ridge from the first bristled segment to the edge of the caudal funnel. Number of bristled segments unknown. Four unarmed segments posteriorly. Caudal funnel has the shape of a fluted vase, with about forty-four cirri, more or less, alternately long and short, the long being flattened and twenty in number. Anal cone a central button.

First three bristled segments have long, pale yellow bristles, and two spines with the tip curved. Bristles with stout shafts, tapered tips, and wings, besides translucent, slender forms with greatly elongated hair-like tips and just a trace of wings. Typical hook with a remarkably high crown of six or seven teeth above the main fang, which leaves the neck at less than a right angle, has a slight incurvation of the throat beneath it, and a comparatively short and nearly straight tuft of gular bristles on each side. The neck and shaft are almost of equal length, and the shoulder is marked. Tube of sand, minute fragments of shells, and Foraminifera; free.

Synonym.

1913. *Axiothella zetlandica*, McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 106.

Habitat.—Dredged by Dr. Gwyn Jeffreys and Canon A. M. Norman in St. Magnus Bay, Shetland, in 100 fathoms in 1867, and in 85 fathoms in the same bay in 1868.

Cephalic plate (Plate XCIX, figs. 6, 6 *a*, 6 *c* and 6 *d*) slopes downward and is concave rather than convex, has a remarkably wide and somewhat thin margin, and a minute central process in front, the general form of the surface being rounded rather than ovoid. From each side of the minute median process the broad and thin antero-lateral flaps pass backward to the notch, which is, though pronounced, superficial—that is, it is confined to the outer half of the flap and its direction is slightly forward. The postero-lateral margin behind the notches is differentiated by its striæ and crenate edge. Six larger marginal crenations are divided into two, three, and four subdivisions. This margin is narrower than the antero-lateral and stands more or less erect, whilst the antero-lateral is procumbent. The very narrow keel arises a little behind the middle, and posterior to two nearly transverse grooves, which run inward from the margin and by a slight enlargement from the anterior edge of a rounded area. It widens as it approaches the median frontal process, and again contracts as it joins it, so that its outline is somewhat clavate, or, if the posterior area is considered, like the gymnastic Indian club. On each side is a long,

slightly narrower ridge, which ceases at the enlargement of the keel in front, but springs from the side of the keel in front of the posterior rounded area. A deep groove lies between the keel and the lateral ridge, and another less pronounced to the exterior of it. The former probably represents the nuchal groove, which debouches anteriorly on each side of the minute frontal process. The groove outside the ridge runs forward in the same direction, but appears to have a less definite termination. The proboscis (Plate XCIX, fig. 6 *a*) forms a somewhat globular, grooved mass, with rows of rather long, conical papillæ (Plate XCIX, fig. 6 *b*).

The *body* is, as usual, narrowed behind the anterior end, and again increases at the eighth segment. Anteriorly the feet arise nearer the anterior than the posterior border of the segment, but posteriorly they are close to the posterior edge. The number of bristled segments is uncertain. The last setigerous process and row of hooks are followed by three narrow, non-bristled segments, bearing rudimentary homologues of the feet in the shape of glandular enlargements, the last forming the prominent ring (Arwidsson's callus-ring) from which the caudal funnel projects. On the ventral surface a ridge runs from the first bristled segment to the edge of the caudal funnel. The body does not diminish much posteriorly, and has a broad, circular shelf in front of the funnel (Plate XCIX, figs. 6 *e* and 6 *f*), from which it projects like a fluted vase—that is, has a constriction immediately above the base and then gradually dilates to the rim bearing the cirri, which, like those of *Axiothella catenala*, are more or less alternately long and short, one of the longer occurring in the mid-ventral line or close to it. The grooved condition of the funnel is a prominent feature, three cirri generally being included in each space, though a narrow one may have only two. One had forty-four flattened cirri, of which twenty were long. The anal cone forms a rounded button at the base of the vase, with the central (anal) aperture surrounded by minute papillæ.

In contrast with *Axiothella catenala* the anterior bristled segments are more glandular, segments 1 to 8 showing glandular rings, especially anteriorly. The bristles of this region also are more prominent than in the other species.

The first three bristled segments bear spines, the first having two or three and the second and third four of the same character. The spines (Plate CX, fig. 5 *b* and 5 *c*) are curved at the strong point and the shaft is striated internally up to the tip. The spines of the third segment are longer. The fourth segment has a considerable row of hooks (about twelve) with long, curved shafts, and a well-marked shoulder from which the neck dilates to the crown. The main fang arises nearly at a right angle to the neck and is rather long. Four teeth occur on the crown behind it, and a short tuft of gular bristles springs from the throat immediately beneath it. They do not reach the tip of the great fang. The crowns of these hooks are little elevated, and thus differ from the typical forms, which those of the fifth foot more nearly resemble. The bristles form conspicuous, pale yellow tufts in each foot, and one group has stout shafts and tapered tips with wings (Plate CX, figs. 5 and 5 *a*), the others are translucent, slender, with greatly elongated hair-like tips and extremely minute serrations, the wings being slightly developed. In the middle and posterior regions of the body they are borne on long, setigerous processes, which form a feature in the outline. They may be contrasted with those of *Axiothella catenala* from the Arctic seas in Plate CX, fig. 4.

The typical hook, as at the eighth segment (Plate CX, fig. 5 *d*), has a remarkably high crown, and neck and shaft are nearly equal in length. The shaft dilates from the base up to the shoulder, then the neck is constricted off, and again dilates to the toothed hatchet-shaped crown, which, with its six or seven teeth, rises high above the main fang, which makes less than a right angle with the neck, and has a distinct indentation of the throat beneath it, opposite which, on the side of the hook or at the notch in the throat, a comparatively short tuft of gular bristles on each side slopes upward and forward instead of curving gently outward and bending round the tip of the great fang as ordinarily seen under a cover-glass. The neck is obliquely striated, and longitudinal striæ occur at the upper end of the shaft. Posteriorly little change takes place in the structure of the hook, the proportions of shaft and neck being nearly the same, but in the last row the number of teeth above the crown is greater. For comparison the hooks of *Axiothella catenala* are shown in Plate CX, fig. 4 *a*.

The tube appears to be free, and to be composed of sand, minute fragments of shells, Foraminifera, and secretion.

This species in 1868 was confounded with *Axiothella catenala*, Malmgren, and hence the description of the apparent differences between them, as indicated in a former paper.[1] Malmgren's description and figure of *Axiothella catenala* are excellent. It comes near *Heteroclymene* and *Pseudoclymene*, but agrees with neither.

Genus CXXIV.—Euclymene, *Verrill*, 1900.

Cephalic region with glands; nuchal organ somewhat long; distinct cephalic rim. Proboscis with flat papillæ. No collar. Anterior segments of body with conspicuous glandular belts. Segment with collar absent. The somewhat large hooks of segments 1 to 3 more or less modified, with gular bristles. Feet of the eighth bristled segment posterior to the middle. Behind the unarmed segments are a prominent ring and a vase-shaped anal region. Ventral cirrus of the latter is longest, the upper cirri shorter. Anal cone lies in a funnel-like cavity. Anterior bristles with wings, and some with a terminal pencil. The posterior have narrow wings and smooth tips. Tube free, straight, and somewhat thick.

Synonym.

1913. *Euclymene* (A), McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 117.

Two fragments, viz. a funnel and a segment of a form apparently a *Euclymene*, were dredged in the 'Porcupine' Expedition of 1869, in 370 fathoms in muddy sand, off Ireland. The funnel, which may belong to a species different from the other fragment, has thirty-four cirri, that opposite the ventral ridge being about double the length of the others. All are conical, flattened cirri. The rim is only slightly wider than the base, and no contraction occurs in the middle. The basal rim, from which the funnel arises, is sloped, and a single unarmed segment is attached to it.

[1] 'Trans. Roy. Soc. Edinb.,' vol. xxv, p. 420.

The separate segment (fragment) has bristles and hooks. The latter have moderately long, curved shafts, increasing in diameter from the base to the shoulder, then narrowing at the neck, which increases in breadth distally, and with a somewhat high crown on which are six teeth behind the great fang, which makes less than a right angle with the neck, and a curved gap (concavity) with a slight eminence exists between it and the origin of the gular bristles, much less, however, than in the hook of *Isocirrus D.*

The bristles are strong and straight, with tapered tips and narrow wings. Beyond the wings in some is a flattened region ending in the delicately tapered tip. The more slender forms do not show traces of wings.

Genus CXXV.—Heteroclymene, *Arwidsson*, 1906.

Nuchal organ rather long. Distinct cephalic rim. Proboscis with flat papillæ. Behind the mouth are two lateral glandular areas. The feet of the eighth segment in the middle. Distinct, naked segments posteriorly, the last being short and overlapping the anal rim. The ventral cirrus of the rim is longest, the others are somewhat long. Anal cone distinct, with the anus prominent. Cephalic plate with distinct glands. The anterior segments with evident glandular bands. The hook-like bristles of segments 1 to 3 are powerful, and develop gular bristles under the main fang in the succeeding segments. The anterior bristles are winged, and have spinous tips. The posterior bristles have smooth tips. Tube free and straight; somewhat thin.

1. Heteroclymene robusta, *Arwidsson*, 1906. Plate C, fig. 23—tail; Plate CIX, fig. 4 and 4 *a*—bristle and hook.

Specific Characters.—The anterior process of the head somewhat small. The cephalic border with lateral notches, and a median one posteriorly. No eyes. Body with nineteen bristled and five terminal unarmed segments; the last being short, and sometimes the fourth also. The anal rim has between the longer cirri a series of shorter ones, but the mid-ventral is longest. Nephridia in segments 7 to 9. Anterior segments 1 to 9 with anterior glandular bands, and the third and fourth have glandular areas behind the feet. In the ninth bristled segment the band is both dorsal and ventral, a triangular area passing in front over the eighth.

Hook-like bristles of segments 1 to 3 short, thick, and somewhat tapered at the ends. The typical hooks with eight to nine teeth. Both kinds of bristles have long points, are best developed in segments 9 to 16, and their basis is prominent. Colour: Third bristled segment with faint red specks behind the feet, the next has specks on the feet and on the anterior region. The fifth also has specks on the feet, segments 6 and 7 have none, and the latter is brownish-yellow posteriorly. The reddish coloration is marked. In one example the cirri and rings near the anus were reddish-brown.

Synonyms.

1906. *Heteroclymene robusta*, Arwidsson. Skand. u. arktisch. Maldan., p. 227, Taf. v, fig. 171, Taf. x, figs. 318—320, Taf. xii, figs. 371—372.
1911. „ „ idem. Proc. Roy. Irish Acad., vol. xxxix, p. 224.
1913. „ ? A B, McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 117.
„ „ *robusta*, Nolte. Wiss. Meeresuntersuch., n.f., Bd. xv, p. 51, Taf. i, figs. 19—21.
„ „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 135.

Habitat.—Ballynakill Harbour (Southern). Off Cape Monday. Norway (Arwidsson).

A beautifully-formed anal funnel (Plate C, fig. 23) with only a fragment of the body, without the bristles, was dredged in 100 fathoms, 30 miles west of Cape Monday, in the 'Porcupine' Expedition of 1870. It is comparatively large, measuring 4·5 mm. in diameter. Viewed laterally it resembles an elegant urn in miniature, with the ventral ridge passing up to its edge and to the longest and largest cirrus. The free edge is neatly cut into minute, rigid, conical cirri, except in the case of three, which are subulate and longer. Two of these are symmetrically placed—four short cirri separating each from the long ventral cirrus, whilst on the right five short cirri separate the odd long cirrus from that adjoining. The total number of cirri is fifty-nine, and of these, as indicated, only four are long. The distal cavity is shallow, a fine series of grooves radiating from the central anus to the spaces between the cirri. The ring from which the funnel arises is rounded and only moderately prominent, whilst externally the wall of the funnel is quite smooth. The winged bristles (Plate CIX, fig. 4) are somewhat stout, with rather sharp tips, and there are also spinous forms. The hooks (Plate CIX, fig. 4 *a*) present a peculiar crown with seven teeth above the great fang, which comes off at more than a right angle, and the gular bristles have no basal enlargement.[1]

Genus CXXVI.—Pseudoclymene, *Arwidsson*, 1906.

The nuchal grooves very short; distinct cephalic rim. The proboscis without papillæ. Cephalic lobe slightly glandular. No collar. The feet of the eighth bristled segment are in front of the middle. The naked segments posteriorly are short, followed by a short, saucer-shaped, terminal one. Anal cirri small, the ventral longest, and the others somewhat irregular. The anal cone short, directed toward the base of the cirrus. Anal "sucker" distinct. The anterior segments with conspicuous glandular belts. The crotchets of segments 1 to 3 are much changed. The shaft of the succeeding hooked bristles gently curved with hairs on the throat. The anterior bristles with broad wings and distinct hair-pencils. The posterior bristles furnished with fine spikes at the tip. Tube free and straight, somewhat thin (Arwidsson).

1. Pseudoclymene quadrilobata, *Sars*, 1856. Plate CVIII, figs. 10 and 10 *a*—bristle and hook; Plate CIX, fig. 5—spine; Plate CXI, fig. 6—head.

Specific Characters.—The ovoid cephalic plate has a prominent lateral margin on each side of the small mid-frontal process, indeed the margin is conspicuous all round, and a

[1] This form can only be briefly indicated at present.

shallow notch and a fold occur on each side, whilst the rim posteriorly dips to a median notch. Narrow keel arises somewhat behind a line between the lateral notches and rims forward to the mid-frontal process. It has a groove on each side, but the curved nuchal grooves proper are anterior in position and short. On the ventral aspect of the mid-frontal process a dark band exists, and this may indicate the presence of eyes in life. Mouth a transverse slit with prominent, furrowed lips. Proboscis apparently smooth. First seven segments markedly glandular, first three bear spines with slightly curved shafts and tips, that of the third segment having the tip most curved. Stronger bristles with straight shafts, tapered tips and distinct wings, the wing ending distally in a peculiar flattened region which is continuous with the slender tip, but no distinctly spinous condition observed; the delicate, slender forms tapered to fine hair-like tips. Hooks commence with modified forms on the fourth bristled segment. The typical hook is distinguished by the great breadth of the distal end, the large angle made by the main fang with the neck, the close application of the gular bristles to the lower border of the fang, and the numerous small teeth on the crown behind it; yet the crown is rounded off instead of being high. The shaft is of moderate length, striated longitudinally, gently curved, the slope from the slight shoulder to the neck is gradual, and the obliquely striated neck dilates in its progress distally. Tube free, composed of sand and shell-fragments. Arwidsson found one fixed to *Lima excavata* in Norway.

Synonyms.

1856. *Clymene quadrilobata,* Sars. Fauna Lit. Norveg., ii, p. 15, Tab. 2, figs. 18—22.
1865. „ „ De Quatrefages. Annel., t. ii, p. 241.
1900. *Euclymene* (*Praxillella*) *quadrilobata,* Verrill. Trans. Conn. Acad. Arts Sci., vol. x, p. 655.
1906. *Pseudoclymene quadrilobata,* Arwidsson. Skand. u. arktisch. Maldan., p. 236, Taf. vi, figs. 181—186, Taf. x, figs. 321—329.
1913. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, pp. 111, 128.

Habitat.—Dredged in 70 fathoms in the Outer Haaf, Skerries, Shetland, 1868, by Dr. Gwyn Jeffreys, of whose successful labours, along with those of Canon A. M. Norman, mention has so often been made. Abroad it has been procured in various localities off the coast of Norway (Sars, Arwidsson).

In this form the cephalic plate is distinguished by the prominence of the lateral margin on each side of the small mid-frontal process—approaching *Arwidssonia zetlandica* in this respect, though the lobes are less and the frontal process is larger. The margin, indeed, is conspicuous all round, and in place of the deep notch of *Praxillella* a shallow notch and a fold occur laterally, whilst posteriorly the margin dips downward gently to a median notch, which is thus less abrupt than in *Praxillella prætermissa*. The outline of the cephalic plate is ovoid, and the keel arises rather behind a line between the lateral notches, and passes forward as a narrow ridge to the mid-frontal process. A groove exists on each side of it, but the nuchal grooves proper seem to be short and anterior in position, forming two curved furrows with the convexity outward, which, anteriorly, debouch on each side of the mid-frontal process. On the ventral aspect behind the frontal process is a dark band, but no distinct eyes are now observable. The mouth forms a transverse slit, with prominent furrowed lips anteriorly and posteriorly and radiating grooves laterally. Arwidsson describes the proboscis as provided with papillæ.

The bristles consist of stronger forms with straight shafts, tapered tips, and distinct wings (Plate CVIII, fig. 10), the wing running distally into a peculiar, flattened region, which ends in the tapered tip, but no serration could be made out. The delicate, slender forms taper to a hair-like tip, but spikes could not be seen in the preparation.

The first seven segments and the anterior part of the eighth are markedly glandular, all having prominent belts in front, and the ventral streak is distinct from the mouth backward. The first three segments bear strong spines with curvatures of both shaft and tip (Plate CIX, fig. 5), the tip of the spine of the third segment being most distinctly hooked. The fourth has a row of hooks with long, curved shafts, the main fang makes a larger angle with the neck than in the typical form, and the gular bristles seem to be rudimentary, yet the hook has much of the character of the type. The hook, as at the eighth segment (Plate CVIII, fig. 10 *a*), is distinguished by the great breadth of the distal end, the large angle made by the main fang with the neck, the close application of the gular bristles to the lower border of the fang—apparently almost springing from the basal edge of the fang itself—and the numerous and small teeth on the crown behind it; yet the crown is rounded off instead of being high. The shaft is of moderate length, striated longitudinally, gently curved, and the slope from the slight shoulder to the neck is gradual, then the neck dilates in its progress distally, and is boldly and obliquely striated.

2. Pseudoclymene Œrstedi, *Claparède*, 1863. Plate C, figs. 22 and 22 *a*—head; Plate CVIII, figs. 12—12 *c*—bristles and hook; Plate CI, fig. 9—tail.

Specific Characters.—Cephalic plate elongated antero-posteriorly so as to be elliptical, the narrow anterior end being continuous with the median frontal process. The rim is not much developed, and the lateral notches and the posterior notch are slightly marked. Keel long, commencing a little in front of the posterior rim and passing forward to the base of the median process, on each side of which the long nuchal grooves end. Eyes present. Proboscis smooth. Body comparatively small, of twenty segments (De St. Joseph). First seven segments shorter and the feet are in front of the centre of each, whereas those behind have the feet toward the posterior border. Four unarmed segments posteriorly, viz. a short, urn-shaped segment, with glandular ridges, and three closely aggregated rings, two of which have glandular thickenings. A ventral median ridge extends nearly from end to end, and it abuts on the longest anal cirrus, which is flattened and not much tapered. The long and the short cirri are arranged more or less alternately, one or two short occurring between the long. Anal cone flattened. First three segments are spinigerous, though occasionally one side of the second and third bear modified and large hooks. Bristles of two kinds: stiffer straight forms with tapered tips and distinct wings, and slender, translucent bristles with long, hair-like tips, which are probably minutely spinous. Typical hook with curved shaft, which is tapered from the shoulder to the base, whilst the neck is narrow inferiorly (above the shoulder) and dilates distally, the main fang leaving the neck at less than a right angle, and behind it is a very high crown with five to six teeth. Almost immediately beneath the great fang is a tuft of gular bristles, which pass forward and curve above the tip of the main fang. Colour clear brown, with red bands on anterior segments (De St. Joseph). Tubes small, free and

cylindrical, composed of secretion with sand-grains, minute fragments of shells, and an occasional Foraminifer; whilst one or two are fixed to small pebbles.

Synonyms.

1863. *Clymene Œrstedi,* Claparède. Beobacht. Wirbellosen Thiere, p. 28, pl. xiii, figs. 8—13.
„ ? „ *digitata,* Grube. Arch. f. Naturges., p. 54, pl. v, fig. 5.
1894. „ *Œrstedi,* De St. Joseph. Ann. Sc. nat., 7e sér., t. xvii, p. 137, pl. vi, fig. 166.
1906. *Euclymene* „ Arwidsson. Skand. u. arktisch. Maldan., p. 218.
1910. *Clymene* „ Elwes. Journ. M. B. A., vol. ix, p. 64.
1913. ?*Pseudoclymene Œrstedi,* McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 92.

Habitat.—Procured between tide-marks in sandy tubes under stones at Guernsey and Herm, 1868; Torquay (Elwes).

The same form was dredged in the 'Porcupine' Expedition of 1870 in Bono Bay in twenty-five fathoms. Adriatic (Grube); shores of France (De St. Joseph).

The cephalic plate (Plate C, figs. 22 and 22 *a*) is somewhat like that of *Praxillella*, with a conical median frontal process, slightly marked lateral notches, and median posterior notch. The rim of the plate is moderately developed, and its outline is elliptical, more elongated antero-posteriorly than any form hitherto observed in Britain, a feature partly due to the continuation of the narrow anterior border into the median frontal process. When the proboscis is included the surface is slightly convex, but when the organ is extruded it is somewhat concave. The keel is long and well marked, commencing a little in front of the posterior rim, and running forward to the base of the median process. The nuchal grooves appear to go along the whole length of the keel, and to bend outward anteriorly on each side of the median process. The arrangement thus differs from that in *Pseudoclymene*, which has very short, nuchal grooves. The slightly-marked lateral and median posterior notches of the rim, as well as the fusion of the outline of the median frontal process with the narrow anterior end of the cephalic plate, distinguish it from *Praxillella*. Eyes were present in the living form, but unfortunately they are now invisible. The proboscis has the usual outline of a globular button on extrusion and is smooth.

The *body* is comparatively small, with a slight constriction anteriorly, and then continues of a nearly uniform diameter to the posterior end. The first seven segments are shorter than those which follow, and their feet are in front of the middle of the segment, while those behind them have the feet toward the posterior border of the segment. The last two bristled segments are shorter than those immediately in front, and behind them are four segments devoid of bristles, viz. a short urn-shaped segment with glandular ridges at the end, and three closely aggregated rings with traces of lateral glandular swellings in two, the last bearing the funnel. The usual median ventral ridge runs from the anterior to the posterior end, where it is opposite the longest cirrus, which is flattened (Plate CI, fig. 9) and not much tapered. The long and the short cirri are arranged more or less alternately, one or two of the short occurring between the long. In the centre is a flattened anal cone with the anus in the middle. The number of cirri varies from seventeen to twenty-three.

The first three segments are spinigerous, and have, beside, the usual tuft of bristles.

The first foot has two minute spines, one slightly curved and tapered from base to apex, the other with a shoulder and blunt tip. The second foot has on one side spines of the foregoing shape, and on the other a modified hook, which has a shaft, narrowed at the base, but thereafter nearly cylindrical to the shoulder and with a short, slightly tapered neck. The main fang is rather long, makes more than a right angle with the neck, and has several rudimentary teeth on the flat crown behind it. The third foot has on one side spines and on the other a single large hook, similar to that in the foregoing foot, but with a more distinct curvature of the shaft and enlargement below the shoulder. The fourth foot shows a series of nearly normal hooks, which are smaller than those of the third, have a marked curve of the shaft, which tapers from the base to the shoulder, the neck being narrowest immediately beyond it, for it dilates thereafter to the crown, the great height of which is characteristic. The main fang leaves the neck at a little less than a right angle, and in lateral view has four or five teeth above it, sloping downward from the high crown. Almost immediately beneath the great fang the gular bristles pass forward and curve above the tip of the main fang.

The neck is slightly striated obliquely, but though the enlargement below the shoulder is somewhat opaque, striæ are indistinct. The hooks vary very little from the typical form (Plate CVIII, fig. 12 *c*), those of the last row in front of the funnel being perhaps somewhat smaller, but having the same high crown, with at least five teeth above the main fang, in lateral view.

The bristles consist of the usual two groups, viz. those with stouter, straight shafts (Plate CVIII, figs. 12 and 12 *a*) and tapered tips with distinct wings, and a dense group of more slender forms with fine, hair-like tips (fig. 12 *a*), besides the spinous kinds (Plate CVIII, fig. 12 *b*) which in the preparations are coated with particles and are minutely spiked in the fresh examples. The bristles at the posterior end are of two kinds, viz. proportionally stout, winged forms, and a few more slender, with brush-like spikes at the tip.

The small, cylindrical tubes are formed of secretion coated with sand-grains, minute fragments of shells, and an occasional Foraminifer, whilst one or two are anchored by the secretion to a small pebble.

This appears to be the *Clymene Œrstedi*, Claparède, which De St. Joseph considers probably to be *Clymene digitata*, Grube, for "deux entailles en anière" of the border of the head, which distinguish it from *C. digitata*, are not mentioned or figured by Claparède.

Genus CXXVII.—Cæsicirrus, *Arwidsson*, 1911.

Nuchal organ of median length; distinct cephalic rim. Cephalic plate with evident glands. Papillæ of proboscis low or absent. Segment with collar absent. The feet of the eighth setigerous segment toward the posterior part. Anterior segments with distinct glandular bands. Achætous segments posteriorly, and behind is a callus-shaped ring, then an anal cup. The ventral cirrus is longest, and the longer cirri, which are symmetrically arranged amongst the others, have filiform tips; the shorter have split tips. Anal cone low—at the bottom of a funnel-like depression, and anal papillæ drawn

out like a finger. Hooks of segments 1 to 3 are not robust, and lack bristles, are more or less changed, and usually stand singly in each foot; neck of fully developed hook is constricted internally, and the gular bristles join under the main fang. Anterior bristles with narrow or vanishing wings and a distinct series of spikes. Posterior bristles have narrow wings and smooth points. Tubes free, straight or rather thin.

1. Cæsicirrus neglectus, *Arwidsson*, 1911. Plate CX, figs. 15 to 15 *a*—bristles; Plate CXI, figs. 5 to 5 *e*—head, tail, bristle and hook.

Specific characters.—Anterior cephalic process rather short; cephalic rim low, with faintly indicated lateral notches; posterior notch also faint. Ocelli numerous, in front of mouth. Feet of the seventh setigerous segment somewhat in front of the posterior third. Nineteen setigerous and three posterior achætous segments. Three pairs of long, anal cirri, besides the ventral; the short cirri—to the number of 1 to 4—occur in each interval. Glandular bands in first seven setigerous segments, and on the fourth the band occupies half the section behind the feet; posterior part of the seventh setigerous segment is completely though sparsely covered with glands dorsally; the second has scattered glands, chiefly in front of feet; the third is similarly and generally covered. The eighth has a distinct glandular band between the middle and the feet. From the middle of the seventh setigerous segment the glandular bands follow the ventral nerve-cord, and are strongly marked from the ninth to the fourteenth segments. More or less faint, longitudinal, glandular bands occur to the front and rear of the uppermost hooks, in the direction of the neighbouring bristles, from the eighth to the twelfth or thirteenth bristled segments inclusive. Hooks of the first three segments have a rather long inner section and three or four teeth; those fully developed behind have six teeth as a maximum. The bristles are specially numerous on the eighth and ninth setigerous segments, and in many of the middle and posterior segments the commencement of the tip is more or less distinctly enlarged. Nephridia in setigerous segments 7 to 9. Cunningham and Ramage state that the colour is pinkish, pale towards the anterior end, with broad bands of deep red surrounding the body at intervals. Tubes rather thin and brittle, of membrane and fine grains of sand—chiefly light in colour.

Synonyms.

1888. *Axiothea catenata,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 679, pl. xlvii, fig. 42.
1911. *Cæsicirrus neglectus,* Arwidsson. Proc. Roy. Irish Acad., vol. xxix, p. 217, pl. xvii, figs. 1—9, pl. xviii, figs. 10—12, and pl. xix, figs. 20—26.
1913. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, p. 112.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 134.

Habitat.—? Firth of Forth, in great numbers, 200 or 300 yards to the west of the Birnie Rocks (Cunningham and Ramage); Blacksod Bay, Galway Bay, and other Irish localities (Arwidsson). In the Forth a change seems to have taken place in the locality (Birnie) since 1887, as no specimen could now be obtained. Liverpool Bay (Hornell) ?

The anterior point of the snout is somewhat short; borders of the cephalic plate

low, meeting in a definite angle posteriorly, and a lateral notch occurs on each side. Numerous ocelli in a rather broad band in front of the mouth. Proboscis smooth. Nuchal organs of moderate length, and separated by a low keel.

Body typical in outline, somewhat slender. Anterior setigerous segments diminished in length to the fifth, after which the sixth and seventh show a slight increase, the latter having the feet in front of the posterior third. The eighth segment is longer, and the feet are near the posterior border. The succeeding segments increase in length, the sixteenth being the longest; then they diminish rapidly. The number of the setigerous segments is sixteen, then follow three achætous segments and a callus-shaped ring. The anal cone is low, and the vent has faint, pointed elevations. On the ventral edge is the long central cirrus, and there are three pairs of subulate cirri about half the length of the central cirrus with shorter ones interposed. In an example kindly sent by Mr. R. Southern most of the shorter cirri had bifid or trifid tips. The longer cirri were subulate or clavate.

Nephridia occur in setigerous segments 7 to 9, with openings beneath the hook-rows. The cephalic plate and anterior segments have glands, a minute account of their distribution being given by Arwidsson.

The anterior bristles (Plate CX, figs. 15 and 15 *a*) have slight wings, but these almost disappear in the posterior segments. A series of fine spikes or hairs is distinct on those of the seventeenth segment (Plate CXI, fig. 5 *d*). The distal fine spikes are not readily seen, indeed none were visible in the preparations of the anterior feet, but they were visible in a posterior foot, where Arwidsson apparently did not find them. They are shorter than the smooth bristles. The points of the bristles increase in breadth on the sixth setigerous segment and are distinct on the ninth, and they seem to vary in the succeeding segment.

The hooks of segments 1 to 3 are usually single and considerably modified, but they are well-developed on the fourth and succeeding segments (Plate CXI, fig. 5 *e*). The great fang comes off at less than a right angle and is curved, whilst five teeth in lateral view occur above it. A slight process for the gular bristles is situated just beneath it, and the neck and shaft, which are separated by a distinct constriction, are marked by parallel striæ internally. The shaft is much curved.

The foregoing description is mainly that of Arwidsson, since a specimen from Mr. Southern only reached me as the MS. went to press. Careful search[1] was made at the locality stated by Cunningham and Ramage, but no trace of the Maldanid could be found, a change probably from increased pollution having taken place in this part of the estuary of the Forth. A certain element of doubt thus remains concerning this species and its relationship to other forms.

Reproduction.—Two females, taken on September 16th at Blacksod Bay, are fairly full of eggs, which are still of different sizes (Arwidsson).

Cunningham and Ramage (1888) found this form in tubes of fine sand, 200 or 300 yards west of the Birnie Rocks in the Forth, buried to a depth of 6 to 8 in., the upper end being simple and open. They describe its colour as pinkish, paler toward the anterior

[1] For which I am much indebted to Mr. Eagle Clarke and the officials of the Royal Scottish Museum.

end, with broad bands of deep red surrounding the body at intervals. The authors thought it identical with Malmgren's *Axiothea catenata*.

Sub-Family Maldaninæ, *Arwidsson.*

Genus CXXVIII.—Maldane, *Grube*, 1860.

Clymenia, Œrsted; *Petaloproctus*, De Quatrefages.

Cephalic plate somewhat elongated, more or less narrowed anteriorly, or pointed, and with a lateral border. The cephalic keel is long and high, extending to the posterior edge. Nuchal organ rather short, straight or slightly curved, not recurved anteriorly, the other end with no deep groove. Posterior plate small, smooth or with marked teeth (processes) or with notches. The fifth bristled segment with an upper half almond-shaped gland from the anterior to the posterior end of the segment. Dorsal bristles capillary, either smooth or serrated distally. Ventral with rostrate hooks having a long manubrium and in a single series.

Claparède (1868) admits with hesitation this genus of Grube's, as revised by Malmgren. As established by Grube it represented an abnormal form with reversed bristles and hooks, the former being ventral, and the latter dorsal. But Malmgren supposes that Grube was deceived by a *prolapsus ani*, so that he mistook the tail for the head. Claparède, however, defends Grube, who described the dorsal trunk as contracting from behind forward, and he refers to the nervous system, which could not have been on the dorsum.

1. Maldane Sarsi, *Malmgren*, 1867. Plate CX, figs. 8 and 8 *c*—bristles and hook; Plate CXI, figs. 8 and 8 *a*—head and tail; Plate CIX, fig. 16—spinous bristle.

Specific Characters.—Border of the head-plate smooth. Two posterior segments without bristles. Ventral border of the posterior plate smooth; lateral notches moderate; dorsal border minutely crenulate. The posterior ventral plate of the sixth bristled segment is less in breadth than in height. The glandular thickening of the ventral surface extends backward to the sixth segment, and thereafter occurs at the setigerous elevations. A lateral belt of striated glandular tissue extends from the sixth segment to the last bristled segment. Dark brown pigment symmetrically arranged anteriorly; darkest fleck behind each nuchal organ; a dark fleck in front and behind the keel (Malmgren); length 70 to 85 mm., breadth 3 to 4 mm. Winged bristles, with curved, tapering tips in front, and similar bristles with narrow wings and long, tapering tips behind. The tips gradually elongate in proceeding backward, becoming hair-like with symmetrical spikes. Hooks with a broad head, a sharp great fang, with two spines in lateral view on the crown above, and the tuft of bristles from the throat below is only a little longer than the great fang. Cylindrical tube of thin, but tough,

membrane, coated with a thick layer of grey mud, fragile; sometimes with fragments of stone and secretion, so as to be firm.

Synonyms.

1865. *Maldane Sarsi,* Malmgren. Nord. Hafs-Annul., p. 188.
1867. „ „ idem. Annul. Polychæt., p. 99, Tab. x, fig. 57.
1875. *Maldani* „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 26.
1878. *Maldane Sarsi,* McIntosh. Trans. Linn. Soc., ser. 2, vol. i, p. 507.
1879. „ „ Tauber. Annul. Danica, p. 122.
„ „ „ Théel. Kongl. svenska Vet.-Acad. Handl., Bd. xvi, p. 56.
1882. *Clymene koreni,* Hansen. Norske Nordhavs-Exped., vol. iii, p. 40.
1883. *Maldane Sarsi,* Wirén. Chætop. 'Vega' Exped., p. 411.
„ „ „ Levinsen. Vidensk. Meddel. Nat. For., p. 145.
1885. „ „ McIntosh. Annel. 'Challenger,' p. 392.
1894. „ „ Bidenkap. Christ. Vid.-Selsk. Forhandl., 1894, No. 12, p. 117.
1897. „ „ Michaelsen. Polych. deutsch. Meere, p. 142.
1898. „ „ idem. Grönländ Annel., p. 128.
1903. „ „ Percy Moore. Proc. Acad. Nat. Sc. Philad., vol. lv, p. 483.
1906. „ „ Arwidsson. Skand. u. arktisch. Maldan., p. 251, Taf. vi, figs. 192—199, Taf. x, figs. 333—338.
1907. „ „ Fauvel. Bull. Inst. Ocean., no. 107, p. 29.
1908. „ „ Percy Moore. Proc. Acad. Nat. Sc. Philad., vol. lx, p. 355.
„ „ „ Ehlers. Deutsch. Tiefsee-Exped., p. 132.
1909. „ „ Percy Moore. Proc. U. S. Nat. Mus., vol. xxxvii, p. 142.
1913. „ „ McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, pp. 118, 124.
„ „ „ Nolte. Wiss. Meeresuntersuch., N.F., Bd. 15, p. 56, Taf. i, fig. 22, text-figs. 1, 2, 3, and 12.
„ „ „ Fauvel. Bull. Mus. Hist. Nat., t. xix, no. 2, pp. 81, 82.

Habitat.—Dredged off Cape Finisterre in 81 fathoms; and off the coast of Portugal in 795 fathoms by the 'Porcupine' in 1870; Station 7, 'Knight Errant.' Along with *Onuphis conchylega*, Sars, and similar mud-dwelling forms in the Gulf of St. Lawrence, *e. g.* 125 fathoms off Cape Rosier; Gaspé Bay, 1871, 1872, and No. 9, 1873; A. 10, 1872; Atlantic coast U. S. A. (Verrill); Siberian and Behring Seas (Wirén); Kara-Havets (Levinsen); Japan (Moore); Azores (Fauvel); Greenland (Michaelsen); North Pacific coast of North America (Moore). It ranges from the North Sea to Norway and Sweden, the Skager Rak, Cattegat, to Spitzbergen, Nova Zembla, Greenland, and abounds on the shores of Canada. It also extends to the Azores, where not a few Arctic forms have been found.

The cephalic plate is very uniform in structure throughout the series, and corresponds with Arwidsson's figures,[1] the general form being somewhat ovoid, with the posterior edge more rounded and elevated into a collar, which curves inward at the notch on the border about a third forward. Bending outward from the front of the notch it passes forward, then flattens outward as it approaches the nuchal organs, the furrow from each of which runs to a slight notch in the margin, the thin plate being continued forward in the median line as a bluntly-conical process above the mouth. A little within (*i. e.*, in front) of the

[1] 'Skand. u. arktisch. Maldan.,' Taf. vi, figs. 194 and 197.

collar posteriorly a prominent median ridge, with a converging oblique muscle on each side, curves upward and passes forward to the thin conical anterior plate, upon which it is lost. In some the ridge is distinctly notched in lateral view. On each side of its base anteriorly are the nuchal grooves, a line from which passes to the notch on the margin. In the majority of specimens slight grooves, which run obliquely forward and outward from the median ridge, give a resemblance to a leaf with its midrib and veins. The mouth opens a short distance behind the anterior border of the cephalic plate, and appears as a puckered dimple, often with a groove in front in ordinary preparations, which often have the snout bent at an angle to the trunk, the mouth being thus carried outward. The peristomial segment is covered dorsally by the cephalic plate and is thus thrust ventrally. It bears no bristles or hooks.

The *body* is continued behind the cephalic plate as a more or less cylindrical region, though much depends on its preparation. Thus some removed from their tubes are quite cylindrical, whilst others, killed in the free condition, show numerous segmental contractions and dilatations. Slight diminution occurs just in front of the caudal disc when viewed from above downward, but, on the other hand, a distinct dorsal increase, terminating at the vent, is evident in lateral view. The dorsum is generally convex throughout, but the ventral surface is more or less flattened, especially after the anterior fifth, where it is ringed and marked by a median line (nerve-cord), which toward the terminal fourth is sunk in a groove, rising, however, toward the caudal plate. The anus terminates dorsally at the end of a ridge, and the margin is slightly crenate. Moreover, a separate papilla just in front of the caudal plate aids in its closure. Occasionally a prolapse of the gut occurs as a flask-shaped hernia, with the narrow neck at the vent. In this the circular and longitudinal fibres of the gut, as well as a thin chitinous layer, are conspicuous. The caudal plate is slightly oblique with regard to the axis of the body, sloping from above slightly downward and forward. In large specimens the most conspicuous rim is the ventral, which forms a collar as far upward as the median notch on each side, above which is a smooth edge, and then the ventral border is marked by about six crenations. Each of these is comparatively broad, with a dimple or depression in the middle of the free edge. They are best seen in large examples. The rim continues upward as a slightly oblique collar, which has a tendency to be flattened out at the dorsal edge, where it is also somewhat narrowed, though in a large example this is not evident. The general shape is ovoid, with a tendency to a somewhat narrower dorsal end. A slight median ridge occurs from the dorsal to the ventral edge, stopping short of the collar in each case.

The peristomial segment has no feature of note except the presence of a lateral furrow on each side from the notch on the cephalic plate. This groove passes backward to the sixth bristle-series running before the glandular elevations and hook-rows; and in some it may be traced a little further backward. The first bristle-bearing segment, like the adjoining, is shorter than those in the centre of the body and more deeply pigmented. Moreover, as Arwidsson has shown, it is largely supplied with glands, and also has non-glandular streaks. The bristles occur as a tuft on each side, and have fairly stout shafts with a short wing distally on the tapering tip (Plate CX, fig. 8 *b*), which is comparatively short and peculiarly curved. This and the next five segments are shorter than those in the middle of the body.

The following segment has a bristle-tuft and an elevated pad or ridge with a short row of hooks, the elevation meeting its fellow of the opposite side in the mid-ventral line. In large examples, however, this ridge is less evident, the whole ventral area being glandular, and the same occurs with the third and fourth segments, the rows in these having a gradually increasing number of hooks. The fifth and sixth segments likewise have a thick glandular coating ventrally and ventro-laterally, the long rows of hooks and the bristle-tuft in each being at the dorso-lateral edge. A differentiated glandular area lies between the sixth and seventh setigerous regions, the ventral surface being glandular as before. At the eighth the glandular area stretches from the setigerous region of one side to the other, and thus characterises it, for the eighth segment has only a small triangular patch in front, the ventral surface being devoid of glands until the ninth setigerous area, which is glandular ventrally and laterally up to the bristle-tuft. In the lateral region, between the eighth and ninth setigerous regions, is a transversely striated glandular band as between the seventh and eighth segments, and this band continues to the last setigerous process. In the large examples the glandular setigerous region at each side is connected by a ventral band of the same tissue, and often an accessory central piece behind it, but toward the tail these are less marked. Two elevations on each side in front of the caudal plate have no hooks or bristles, but they seem to be glandular.

The bristles project from the dorsal end of each row of hooks, and consist of two groups, viz. an anterior with a marked curve after the appearance of the wing (Plate CX, figs. 8′ and 8 *b*) and with a finely tapered tip, and a posterior group which in the first foot have a similar shaft with a straight tip, with narrow wings and a few distinct spikes on the finely tapered extremity (Plate CX, figs. 8 and 8 *a*). In the next bristled segment (second) the anterior bristles with the curved tips and broad wings have the tapering tips furnished with one or two pairs of spikes which arise opposite each other. The long posterior (or inner) bristles have narrow wings with long, hair-like tips, the stronger series of which do not show spines thereon. A more slender series, however, has the very long, hair-like extremity minutely and symmetrically spinous. The succeeding feet present bristles with larger and longer hair-like tips in both series, and these delicate extremities are all similarly spinous, that is, the sides are armed with symmetrical pairs of spikes. Toward the posterior extremity, as in the last two bristled segments, the bristles are very long, yet each group retains certain of the characters observed in front; the anterior series showing the curvature of the tip, and both having long and attenuate spinous prolongations, the posterior, however, far exceeding the other in length. The hooks (Plate CX, fig. 8 *c*) are characterised by a long, curved shaft, which gently enlarges from the base to the shoulder and is striated and tinted. The tip is contracted beyond the shoulder, is paler, then gently dilates to the neck and crown, the centre being also striated longitudinally. The great fang leaves the neck at somewhat less than a right angle, and has a little below it a tuft of stiff hairs, which often curve upward beyond the fang. The great development of the spines behind the main fang makes the crown broad, though only two spines can clearly be made out in lateral view. In antero-posterior view, in all probability, additional points may be seen.

Arwidsson notes that the segmental organs extend from the seventh to the ninth segment.

This author also gives a table showing the number of hooks in the rows from the second to the nineteenth, and, so far as can be judged, they seem to increase, as a rule, with age and size. In the majority of the setigerous processes, that is after the fourth, they are in a double row.

In various small examples a triangular shield-shaped elevation occurred on the dorsum between the fifth and sixth bristled segments, with the broad end in the front, on bold transverse folds. In large examples transverse folds in this region are not infrequent: such appear to be due to contraction in preparing.

The tubes are formed of greyish mud and are rounded and generally cylindrical. They retain their shape in the preparations, though when pressure is applied by the fingers they readily crumble. Some present transverse elevations or ridges, and arenaceous Foraminifera are included in the thick coating of mud over the central tube of tough secretion. A few of the large tubes are much more consistent, since small stones and tough secretions enter largely into their structure, whilst others have a very firm (brittle) outer layer of secretion and brown mud, whilst the thicker interior layer is softer. Moreover, the tube may be slightly moniliform with an enlarged ring toward one end, which tapers to a thin termination. Such brownish moniliform tubes are coated with grey mud, showing that either a change of site or a selection of materials had been made, unless it is to be supposed that the secretion affects the hue of the mud. In a few, hard flinty grains cause the firm tube to have a surface like sand-paper. The tube is remarkable in so far as the sand can be removed from the very thin, transparent lining of secretion.

This is a northern form, abundant in the colder areas, but, so far as known, it has not hitherto occurred in the British area. A variety (*M. Sarsi*, var. *antarctica*) has recently been described by Arwidsson, from Graham's Land, South Georgia, and other parts of the Antarctic region; so that the distribution of this species is noteworthy.

A minute form in a tube of secretion coated with fine sand was dredged in Bono Bay by the 'Porcupine' in 1870. In external appearance, viz. in the slope and structure of the cephalic plate, and in the truncated and notched anal plate, it closely resembles *M. Sarsi*, though perhaps the latter (anal plate) is more circular. The hooks also appear to correspond, having in lateral view two teeth behind the great fang, and indications of a third.

It is doubtful if the *Maldane glebifex* of Grube[1] (1860) is other than this species, the author having described and figured the anterior for the posterior end and *vice versâ*. The figure of the hook is too elementary for discrimination.

Maldane glebifex, Grube (after Arwidsson), Zoologische Jahrbücher.

The anterior region dotted with small, round, brownish specks. The cephalic keel is present posteriorly, but is lost on the anterior plate. Two naked segments posteriorly. The posterior shield has its ventral border serrated. The anterior and posterior parts of the third bristled segment and the anterior part of the fourth with glandular thickening. The fifth has at its posterior part small half-moon-shaped glandular bands. The sixth posteriorly has small, lateral, glandular spots (under the nerve-cord), and the following segments have similar flecks. The posterior shield with glandular bands at the border.

[1] 'Archiv für Naturgesch.,' Bd. xxvi, p. 92, Taf. iv, figs. 4—4 *c*.

The gular bristles of the hooks are well developed, and the teeth are five to six. The tips of the bristles have alternate spikes.

Grube holds that Fauvel's form (*Maldane Sarsi*) belongs to a variety—his *Maldane glebifex*, var. *transversi-maculata*, n. var., in which the anterior flecks of pigment are developed dorsally, and form transverse bands at the posterior borders of the three anterior bristled segments. They are most distinct on the first.

Fauvel procured his specimen from Belle-Ile-en-mer, in 19 metres.

Fauvel (1909) illustrates the variations in the crenations of the anal region from Spitzbergen, the Azores, and two from Belle Isle (France).

In Nolte's recent account (1913) of the Maldanids of the north and east seas the text-figures of the crown of the hook are shown from the front, but such sketches, though interesting, are less useful than lateral views in discriminating species.

Genus CXXIX.—Asychis, *Kinberg*, 1866.

Chrysothernis, Kinberg; *Sabaco*, Kinberg; *Maldanopsis*, Verrill.

Cephalic plate somewhat long, with a short and broad lateral border, the keel short and flat between the nuchal organs, which are somewhat large and curved. The posterior or anal plate with a more or less notched border, and a deep fissure on each side. The fifth bristled segment has a half-moon-shaped patch of glands.

1. Asychis biceps? *Sars*, 1861. Plate CI, figs. 7 and 7 *a*—head and tail; Plate CVIII, fig. 14—hook; Plate CX, figs. 6 and 6 *a*—bristles and hook.

Specific Characters.—The cephalic plate is cut into two divisions, and the hind border is serrated; an accessory process on the border in front with notched edges on each side of the median keel. Nuchal organ a curved groove on each side. The first bristled segment has an anterior fold or border (collar), and the last two segments are devoid of bristles, whilst the four in front of these are narrow and have very prominent glandular masses at the feet. The brown colour of the anterior region is bold, but interrupted (Arwidsson). The glandular belts and areas are somewhat like those of *Maldane Sarsi*. Length 135 to 180 mm. The anal plate is broader dorsally than ventrally, with a marked fissure in the mid-dorsal line, and a less marked gap in the mid-ventral line. The lateral fissure is deep and wide at the bottom. The dorsal edge of the plate is indented by shallow notches, which are not quite regular, four to six teeth and additional flat portions occurring on each side. The ventral half of the cup or plate shows three or four shallow indentations on each side of the mid-ventral notch. Between the dorsal and the ventral notches is a median line, but no ridge. Anterior bristles with shorter and broader wings and a curved tip, whilst others have longer and narrower wings. The posterior bristles have much elongated hair-like tips with opposite spines. The hooks have very long, curved shafts, and a marked shoulder. The neck is fairly long, the great fang prominent, and the spikes on the crown little elevated. The tube of fine mud is thick, and lined by a firm secretion.

Synonyms.

1861.	*Clymene biceps,*	Sars.	Nyt Mag. f. Naturvid., ii, vol. xi, p. 257.
„	„	„	idem. Christ. Vid.-Selsk. Forh., p. 93.
1865.	„	„	De Quatrefages. Annel., t. ii, pp. 657 and 665.
1866.	*Maldane*	„	Malmgren. Nord. Hafs-Annul., p. 188.
1867.	„	„	idem. Annul. Polychæt., p. 98, Tab. xi, fig. 58.
1868.	„	„	Sars. Christ. Vid.-Selsk. Forh., p. 10 (sep. copy).
1874.	„	„	McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875.	„	„	idem. Invert. and Fishes St. Andrews, p. 127.
1878.	„	„	idem. Trans. Linn. Soc., ser. 2, vol. i, p. 507.
1879.	„	„	Tauber. Annul. Danica, p. 121.
1883.	„	„	Levinsen. Vidensk. Meddel. Nat. For., p. 145.
1894.	„	„	Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 116.
1897.	„	„	Michaelsen. Polych. deutsch. Meere., p. 142.
1906.	*Asychis*	„	Arwidsson. Skand. u. arktisch. Maldan., p. 263, Taf. vi, figs. 200—207, Taf. x, figs. 339—344.
1908.	„	„	Bidenkap. Zool. Anzeiger, Bd. xxxiii, p. 275.
1909.	*Maldane*	„	Fauvel. Bull. Inst. Ocean., no. 142, p. 12.
1911.	„	„	idem. Ibid., no. 194, p. 30.
1913.	*Asychis*	„	McIntosh. Ann. Nat. Hist., ser. 8, vol. xi, pp. 112, 128.
„	„	„	Nolte. Wiss. Meeresuntersuch., N.F., Bd. xv, p. 61, Taf. i, figs. 23—24.
„	„	„	Fauvel. Bull. Mus. Hist. Nat., t. xix, no. 2, p. 10.

Habitat.—Dredged by the 'Knight Errant,' in 35 to 37 fathoms, off Castle Walker, Loch Linnhe, September 7th, 1882.

Not uncommon in Norwegian waters, and extending to Greenland and Iceland, as well as to Sweden and Finmark; 300 fathoms off Norway (Sars).

The cephalic plate (Pate CI, fig. 7) slopes downward and forward as in allied forms, but the entire border as well as its surface differs from that of its allies. Thus the frontal margin is almost the breadth of the body and is entire, and behind it ventrally is the mouth in the form of a longitudinal slit from the anterior edge of which a line slopes backward and outward on each side. Three large serrations occur on each side between the cleft at the margin of the ventral edge and the deep lateral fissure, one of these processes occasionally being bifid. The deep furrow from the fissure proceeds as far as the first bristle-tuft. The rest of the lateral margin and the posterior edge of the cephalic plate are cut into a continuous series of small serrations about eighteen in number. In small examples there are fewer, viz. from eight to twelve. The surface of the cephalic plate has a flat ridge in the centre, but it does not reach either the anterior or the posterior border. The nuchal organ forms on each side a slightly flattened semicircle, commencing anteriorly at the cleft of the frontal plate, then curving inward and running parallel to the median ridge, and again bending outward to the groove at the deep lateral fissure.

Immediately behind the mouth is a broad rectangular band of glands bounded laterally by the groove from the deep fissure of the cephalic plate. Glandular tissue also appears around the mouth. The next segment has a collar with a free edge in front of the bristle-tuft, a narrow ring behind completing the segment. Both are glandular, dorsally and ventrally.

This is a large form measuring in its incomplete condition 110 mm. and probably exceeding 5 in. in length, and having a diameter of 3 or 4 mm. The anterior region is, however, absent or represented only by a small papilla projecting forward from the cicatrising end of the trunk. Judging from the appearance of the specimen and the condition in other forms only a bristled segment with the head and peristomial segment are absent, this making the total number of bristled segments nineteen.

The anterior region has somewhat the same arrangement of the glandular tissue as in *Maldane Sarsi*, though of course it is only present in the specimen from the second bristle-tuft. The second and third bristled segments have a glandular ventral surface which is continuous with a nearly complete dorsal investment. Dorsally, however, a blank occurs from the anterior border of the fourth segment, which has a thin glandular streak, backward. A thick streak occurs dorsally opposite the bristles of the fourth segment, but the great glandular belt from the ventral surface appears at each side dorsally in the second ring of the segment at the bristle-tuft. The first ring of this segment ventrally is less thickly glandular than the second, which has a lozenge-shaped area with fewer glands in the mid-ventral line. The great fifth segment shows dorsally the thick, bifid lateral pads on each side of the bristles, whilst ventrally it has a semicircular patch in front, the thin ends being visible dorsally, and a broad and continuous belt behind. The sixth has a glandular streak dorsally between the bristle-tufts of opposite sides, and the ends of the ventral belts are seen in front and at the feet, as in the previous segment. Ventrally the anterior only exhibits a fissure, wider laterally, between it and the continuous and broad posterior belt of glandular tissue. The next (seventh) segment has anteriorly the dorsal ends of the glandular area of each foot, as well as a small portion of the anterior ventral belt seen at the sides. Ventrally a somewhat semicircular glandular area lies in front, its posterior edge in the preparation being somewhat indefinite. The glandular belt at the feet is also continued from side to side. Thereafter, as a rule, the bifid glandular areas at the feet are alone visible from the dorsum. Ventrally the belt between the feet is distinct at the eighth, ninth, and tenth, is more or less interrupted on the eleventh, twelfth, thirteenth, and at the succeeding feet the glandular tissue is confined to the sides of the feet, forming prominent ovoid enlargements in each case. A median streak occurs in the mid-ventral line from end to end. The proboscis is a flattened bladder-like organ with papillæ.

In the general form of the body this species approaches that of *Maldane Sarsi*, though in the large example the last four bristled segments were more prominent and closer together. They are followed by a narrow ring and then the anal plate. The first six bristled segments are comparatively short, whilst those following are longer, and the fourteenth and fifteenth are again somewhat shorter. The last four diminish progressively, and in the prominent and broad glandular feet agree with the figure of *Maldane bicceps* given by Malmgren. A single narrow ring devoid of bristles follows the nineteenth bristled segment, and it has a glandular area at each side. The anal segment (Plate CI, fig. 7 *a*) has dorsally the transversely ridged eminence for the vent, with its valve-like plug at the opening behind, a process passing off from this toward the median fissure of the anal cup. This cup is broader dorsally than ventrally, with an acute fissure in the mid-dorsal line and a more obtuse one in the mid-ventral line, the lateral slit at each side

penetrating deeply and having a gaping opening at the bottom. The dorsal edge of the anal plate is indented by shallow notches, which, however, are not quite regular, for on the right six teeth and a flat area at the lateral fissure occur, while on the left four teeth and two flat areas are found. The ventral half of the cup shows three or four shallow indentations on each side of the mid-ventral notch. Between the dorsal and the ventral notches is a median line, but no ridge. The anal plate presents therefore small differences from the descriptions of Malmgren and Arwidsson, but these would appear to be due chiefly to the more distinctly marked notches on the border. A dimple occurs at the base of the caudal plate behind a slight ring, which on this surface is between the first non-bristled segment and the caudal rim. The segmental organs, according to Arwidsson, occur from the seventh to the ninth segment.

The anterior bristles are for the most part absent in the example, but, so far as observed, they agree with the descriptions of Malmgren and Arwidsson, viz. those with broader and shorter wings and a curved tip, and those with narrower wings and longer tips. The posterior bristles have much elongated slender tips, with opposite spikes. The same kind of bristle (Plate CX, fig. 6) occurs in the posterior third, each bristle having a well-marked curve and the tip forming a very long, delicate, serrated hair.

The hooks of this form appear to be longer than those figured by Arwidsson; indeed, if his figure (Taf. x, fig. 340) is perfectly typical for *Asychis biceps*, then doubt remains as to the specific identity of the British specimen. The example from the 'Knight Errant' (Plate CVIII, fig. 14, and entire in Plate CX, fig. 6 *a*) differs in having the spikes on the crown less elevated above a line passing from the lower border of the great fang backward, and thus the hook has a different character in that region. The same difference from Malmgren's figure is observed. The smaller teeth on the crown appear to pass on each side of the base of the great fang; at any rate raised striæ are there. The opaque striæ running from the crown along the neck to the shaft are much more strongly developed than in the hook shown by Arwidsson. The curvature above the capillary bristles of the throat differs, the neck itself is proportionally longer, and the outlines of the neck to the shoulder are not in agreement. The great length and curvature of the shaft is not fully indicated by either author, so that this point remains uncertain. Arwidsson gives in detail the number of the hooks in each segment, the chief feature being that they appear to increase with size and probably with age.

The tube is a massive structure of grey mud 7 to 8 mm. in diameter, and at one end tapered to a blunt point (closed). The interior, which has a diameter of 4 mm., is smooth, being lined by a somewhat firm membrane secreted by the glands.

De Quatrefages (1865) simply quoted this and the previous account from the paper of Sars.

Arwidsson found the anterior end regenerated, as might be anticipated from the condition of the various examples. *Loxosomæ* occurred on the anterior segments of an example of 70 mm. from Norway (Arwidsson).

Reproduction.—Arwidsson notes that female reproductive elements ripen in August.

The same author[1] (1908) satisfied himself by an examination of the specimen from

[1] 'Zool. Anzeiger,' Bd. xxxiii, p. 275.

the Oceanographical Museum at Monaco that Fauvel's example with twenty bristled segments and only a single segment without bristles posteriorly was this species.

Fauvel (1909) adheres to the genus *Maldane* of Malmgren for this species, and points out in reply to Arwidsson that neither De St. Joseph nor Orlandi in their revision of the Maldanidæ cared to revive the genus *Asychis* of Kinberg.

2. Asychis Jeffreysii,[1] n.s. Plate CI, figs. 6 and 6 *a*—head; Plate CVIII, fig. 13—hooks.

Specific Characters.—The rim of the cephalic plate has four subulate processes anteriorly on each side, the frontal plate is not separated by notches, and the posterior margin is more minutely serrate than in *A. biceps*. The fissure behind the antero-lateral papillæ is deep. The nuchal organs form a loop on each side with the convexity directed forward, the inner limb of each abutting on the broad median ridge which commences posteriorly about a third of the distance forward. Combined cephalic and buccal regions somewhat shorter than in *A. biceps*.

Foot with strong capillary bristles, many with finely tapered and spiked tips, with a very narrow wing beneath; and slender forms spiked from a short distance above the base to the tip.

Hooks boldly curved with about five teeth above the main fang, which makes a little less than a right angle with the neck. Curve between the main fang and the prominent process for the gular bristles. The neck is somewhat long and constricted above the shoulder, and the shaft is long. Other characters as in *A. biceps*; but the anal region is unknown.

Synonym.

1913. *Asychis* ?, fragment. Ann. Nat. Hist., ser. 8, vol. xi, p. 118.

Habitat.—Dredged in the 'Porcupine' Expedition of 1870 off Cape Finisterre in 81 fathoms.

The cephalic plate (Plate CI, figs. 6 and 6 *a*) in this form is distinguished at once from that of *A. biceps* by the presence in lateral view of four subulate processes on each side anteriorly, by the more minutely serrate condition of the posterior border, by the absence of a notch separating the anterior plate on each side from the region of the papillæ, and by the less prominent frontal margin. The fissure behind the region of the papillæ is deep, and is continuous with a furrow on each side of the neck. Moreover, the curves of the nuchal organs differ, since, instead of forming a semicircle in the mid-cephalic region, the groove forms a loop with the convexity directed forward and the limbs backward, the inner limb of each abutting on the broad median ridge, which commences posteriorly about a third of the distance forward. The whole aspect of the plate thus diverges.

It is not possible to give a detailed account of the body of this form, for only fragments of the anterior region are known, but so far as can be observed the combined

[1] Named after Dr. Gwyn Jeffreys, who did much for the collection of rare annelids.

cephalic and buccal region is shorter, and the collar on the anterior edge of the first bristled segment less developed, though a similar fold occurs on each side at the groove, near the first foot which has a tuft of stout bristles with tapered tips and may have very narrow wings, but in the shorter developing forms these are indistinguishable.

The typical foot has a tuft of strong capillary bristles, many of which have finely tapered tips with spikes, and beneath the spiked region a very narrow wing as in *A. biceps*. A tuft of much more slender forms accompanies these, with minutely spiked tips, whilst longer, slender forms, spiked from the tip to a little above the insertion, occur amongst the stronger forms first mentioned. Few of the bristles, however, were entire. A distinct papilla marks each foot anteriorly.

The hooks (Pl. CVIII, fig. 13) are characterised by their bold curvature, the prominent process from which the gular bristles spring, the nature of the interval between the process and the great fang, which makes a little less than a right angle with the neck, and by the presence of five teeth above the main fang. The neck is rather long and constricted above the shoulder, and the gular bristles curve upward to the second tooth on the crown. Compared with a smaller example of *Asychis biceps* from Norway, the contour of the crown differs, the space between the main fang and the gular bristles is larger, the process giving origin to the bristles larger, and the neck of the hook is longer. These characters are more pronounced in the larger *Asychis* from Loch Linnhe in which the gular bristles are still closer to the neck and fewer teeth occur above the main fang. In lateral view, of course, all the teeth are not seen. A considerable margin has to be given for variation, but the form procured by the 'Porcupine' differs from the two mentioned and also from Arwidsson's figure.

Family XXV.—Ammocharidæ, *Malmgren*, 1867.

Cephalic lobe confluent with the buccal, variable or with a series of branched (peristomial ?) branchiæ. Buccal segment devoid of bristles. Body somewhat short, rounded, slightly attenuate posteriorly, segments few, anterior longer than broad, posterior decreased in length, bristled. Posterior end variable. Intestine straight. Dorsal bristles capillary, in slender fascicles; ventral, numerous, minute, unciform, with curved tips, shaft straight, arranged in transverse rows. Tubicolar; tubes flexible, covered with grains of sand and fragments of shell, and immersed in sand.

In the structure of the body-wall this species offers certain important features, since the central nervous system is situated in the hypoderm, which is well-developed throughout, but as a special account will elsewhere [1] appear, it has been thought unnecessary to go into detail. The absence of oblique muscles, and the special glandular organs are noteworthy points.

Claparède, who states that the cuticle [2] in this form is tough, observes that the vascular plexus on the intestine resembles that in the Serpulidæ. In the mid-region is a large

[1] Festschrift for Professor Ehlers of Göttingen, 1915; but the war may necessitate a different publication.

[2] Other authors describe the cuticle as occurring only anteriorly, the epiderm alone being present posteriorly.

peri-intestinal sinus, which in the neighbourhood of the œsophagus breaks up into a plexus and gives branches to the ramified processes anteriorly, the current in which may be constant in direction. The intestinal sinus in this form is placed between two thin layers of circular muscular fibres, as in the Serpulids, and, as in them, bridles also exist in the sinus, though they are fewer. He found the vessels in the branchiæ in *Owenia* distributed in a homogeneous semi-fluid medium—from the cœlomic space (and the ova floated into them also), and the two hypodermic layers of which were connected by bridles. He speaks of these as having also branchial cartilage. He could find no trace of the cords in *Owenia fusiformis* in sections, and even in the fresh examples it is difficult to see the nerve-cords. He, indeed, ultimately found them, but they had not the normal histological characters.

Gilson, again, thought that no cœlomic epithelium lined the muscles internally, a view opposed by Drasche and Ogneff.

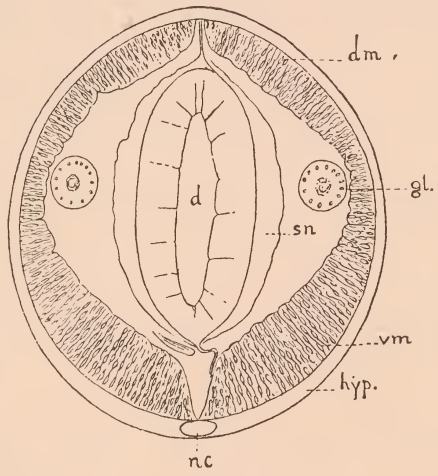

Fig. 135.—Transverse section of the anterior third of *Owenia fusiformis*, Delle Chiaje. *gl.* Mucous glands. *sn.* Vascular sinus round gut.

Malmgren wisely separated, as Claparède states, this group from the Maldanidæ, with which the elongation of their segments and their tube-dwelling habits correspond. The inclusion of the intestine in a vessel is a feature at variance with all other groups of the Polychæts except the Serpulids; and their cephalic branchiæ are also peculiar. Claparède thought the family intermediate between the Maldanidæ and the Serpulids, a group with which Sars, indeed, thought they should be united.

The genus *Ammochares* was included in the Maldanidæ in 1851 by Grube, who, in 1846, described the species *A. ottonis*, but four years previously Delle Chiaje had given an account of the same form under the name *Owenia fusiformis*.

This type was briefly alluded to by De Quatrefages (1865) at the end of the Maldanidæ, and adjoining *Clymenides* and *Arenia*, the genus *Ammochares* being apparently regarded as one of the Maldanidæ. The only species mentioned is *Ammochares ottonis*. The position of the group remained for a considerable time uncertain, some, like Grube (1869), associating it with the Maldanidæ.

The Ammocharidæ formed the sole family under Levinsen's[1] (1883) Ammochari-

[1] Op. cit., p. 180.

formia, and in this he offends no canon of classification. They are placed after the Maldanidæ as Malmgren and De Quatrefages did, but instead of being followed by the Hermellidæ, as in the former author's arrangement, Levinsen places the Amphictenidæ next. His genera are *Myriochele* and *Owenia*.

The Ammocharidæ were placed by Benham (1896) under the second sub-order (Spioniformia) of the order Nereidiformia. Their structure, however, does not agree with their surroundings in this position.

Häcker (1896)[1] considered the Mitraria-larva of *Owenia* as that of *Magelona*. Later (1898)[2] he describes and figures two forms from the 'National' Expedition to the Atlantic, viz. *Mitraria skifera* and *M. Mülleri*, the former with pointed, sabre-like bristles, and the latter with pointed, club-shaped bristles. He does not, however, connect them with a particular family of Polychæts. A remarkable allied type is *Rostraria*, a form also with long tentacles and several pairs of long, swimming bristles.

De St. Joseph (1898) thought the group approached the Maldanidæ and Serpulidæ, especially the former, in their cylindrical body, in the irregularity of the segments, and in the nature of the bristles and the hooks, which in their number, however, approach those of the Serpulidæ; yet the thread-glands are found in neither group.

Gilson (1898), who has devoted much attention to the structure of *Owenia*, describes the body-wall as composed of only two coats, an epidermal (without a cuticle) and a musculo-granular. The latter has a layer of gland-cells so intimately associated with it that he is of opinion they are practically continuous. The glandular lining secretes albuminoid substances, fatty bodies, and urea. The former furnishes the spermatic plasma in the male, and in the female floats the eggs and gives them an envelope. Since the nephridia have lost the function of urinary secretion, moreover, it is this glandular coat which takes up that function, and the granules on the dorsal wall are conducted to the genital funnels (transformed nephridia).

The family of the Ammocharidæ forms a comparatively recent introduction into zoological literature, and yet its representatives, though few, are world-wide in their distribution. No mention is made of any species in Dr. Johnston's 'Catalogue of the Non-Parasitical Worms,' though in 1842 Delle Chiaje had described and figured *Owenia fusiformis*, the common form on the British shores, and which is often tossed in hundreds on the west sands of St. Andrews after storms. The genus *Myriochele* appears to be more or less a deep sea form, the example procured by the 'Challenger' being from 2975 fathoms on a bottom of red clay.

Genus CXXX.—Owenia,[3] *Delle Chiaje*, 1842, Ammochares, *Grube*, 1846.

Cephalic rim with dichotomously divided branchiæ, arising from a campanuliform membrane. Body rounded anteriorly, tapered posteriorly, and ending in a papillose

[1] 'Zeitschr. f. wiss. Zool.,' Bd. lxii, p. 86.

[2] 'Biol. Centralblatt,' Bd. xviii, p. 96, figs. F and G.

[3] *Owenia*, as Grube points out, has been used by Kölliker for a Cephalopod and also for one of the Ctenophora.

anus, sometimes bilobed. Segments variable in length, the anterior region of three segments bearing only bristles, the posterior bearing both bristles and hooks. A broad belt of modified hypoderm stretches backward from the collar on each side in the dorso-lateral region. Slender capillary bristles with spikes tapering distally. Hooks minute and very numerous, with bifid tips. Larva a Mitraria.

1. Owenia fusiformis, *Delle Chiaje*, 1842. Plate XCII, fig. 6; Plate CI, figs. 8—8*f*—tube, branchiæ, etc.; Plate CX, figs. 9—9*b*—bristle and hook.

Specific Characters.—Cephalic region truncated, having dorsally a rounded elevation, the longer diameter of which is transverse; laterally two lobes sometimes marked by an oblique groove slanting from above downward and inward, and having the mouth at their anterior border. A bilobed process with a tongue-shaped ventral appendage projects below the mouth. Cephalic rim has three pairs of dichotomously divided branchiæ, the distal divisions being short, glandular, and truncated. They are semi-transparent, greenish-blue or yellow, and tinted with red; those from Naples being blood-red and pigmented with brown. A collar around the branchiæ. Body 30 to 60 mm. in length, firm and rounded anteriorly, tapered posteriorly, where it ends in a papillose anus—sometimes bilobed. Segments twenty-three to thirty in number, and they vary much in antero-posterior diameter, whilst the body is divided into an anterior and a posterior region. The anterior region consists of three segments bearing only dorsal bristles; the posterior region has from seventeen to twenty-five segments, bearing both dorsal bristles and tori for hooks ventrally. The first three segments are long, whilst the eighth bristled segment inaugurates a change, for it has no dorsal glandular bands, though it has hooks and bristles. Bristles of one type, viz. slender, tapering forms with spikes directed distally. The tori bear a vast number of minute hooks, the neck having a forward bulge below the tip, and then a shoulder below, after which the long shaft tapers gradually to a long, slender thread. Hooks minute, bifid at the tip and with a prominent convexity posteriorly. Tube with a thick internal lining of secretion which forms two conical, elastic, and membranous ends, whilst the general surface is densely covered with imbricated fragments of shells.

Synonyms.

1842. *Owenia fusiformis*, Delle Chiaje. Descriz., pl. 175, figs. 1—6.
1846. *Ammochares ottonis*, Grube. Arch. f. Naturges., Bd. xii, p. 163, pl. v, fig. 2.
1851. „ „ idem. Fam. Annel., pp. 77 and 137.
„ „ *assimilis*, Sars. Nyt Mag. f. Naturvid., Bd. vi, p. 201.
1853. „ „ idem. Ibid., Bd. vii, p. 390.
1861. „ „ Danielssen. Ibid., Bd. xi, p. 54.
1864. „ *ottonis*, Kölliker. Kurzer Bericht, p. 10.
„ „ „ idem. Wurzb. Naturw. Zeitschr., Bd. v, p. 241.
1865. *Ops digitata*, Carrington. Annel. Southport, p. 11.
„ *Ammochares ottonis*, De Quatrefages. Annel., t. ii, p. 249.
1867. „ *assimilis*, Malmgren. Annul. Polychæt., p. 101, Taf. 11, fig. 65.

1868. *Owenia filiformis,* Claparède. Annél. Nap., p. 446, pl. xxvi, fig. 5.
1869. *Ammochares ottonis,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, p. 422, pl. xv, fig. 14.
„ „ *assimilis,* Grube. Abh. Schles. Gesell., p. 10 (sep. abdr.).
1871. „ „ Metschnikoff. Zeitschr. f. wiss. Zool., Bd. xxi, p. 233 (Mitraria).
1873. *Owenia fusiformis,* Claparède. Annél. Sedent., pp. 85, 107, and 129, pl. viii, figs. 8—12.
1874. „ *filiformis,* McIntosh. Ann. Nat. Hist., ser. 4, vol. xiv, p. 203.
1875. „ *brachycera,* Marion. Rev. Sc. nat. Montpell., t. iv, p. 312.
„ *Ammochares assimilis,* Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 27.
„ *Owenia filiformis,* Panceri. Atti Soc. Ital., vol. xviii, p. 535.
„ „ „ McIntosh. Invert. and Fishes St. Andrews, p. 128.
1878. „ „ idem. Trans. Linn. Soc., ser. 2, vol. i, p. 507.
1879. *Ammochares assimilis,* Tauber. Annul. Danica, p. 125.
„ „ „ Théel. Kongl. svenska Vet.-Akad. Handl., Bd. xvi, p. 59.
1883. „ „ Wirén. Chœtop. 'Vega' Exped., p. 412.
„ *Owenia assimilis,* Levinsen. Vidensk. Meddel. Nat. For., p. 148.
1885. „ *filiformis,* Drasche. Beitr. z. f. Anat. Polych., Wien, p. 22, 2 plates.
„ „ „ Carus. Fauna Medit., p. 253.
1887. „ *fusiformis,* Eisig. Capitell., p. 336.
1888. „ *filiformis,* Cunningham and Ramage. Trans. Roy. Soc. Edinb., vol. xxxiii, p. 656.
1891. „ „ Hornell. Trans. Biol. Soc. Liverpool, p. 252.
„ *Ammochares œdificator,* Andrews. Proc. U. S. Nat. Mus., p. 296.
1893. *Owenia filiformis,* Hornell. Journ. Mar. Zool. and Micr., vol. i, p. 13.
„ „ *fusiformis,* Lo Bianco. Atti Accad. Sc. Nap., 2e sér., v, p. 22.
„ „ *assimilis,* Levinsen. Kanonb. "Hauchs," p. 346.
1894. „ *fusiformis,* Gilson. La Cellule, x, p. 299, one plate.
„ „ „ idem. Anat. Anzeiger, x, p. 191, with five figs.
„ „ *assimilis,* Bidenkap. Christ. Vid.-Selsk. Forhandl., p. 117.
1895. „ „ Gilson. Rep. Brit. Assoc. for 1894, p. 693.
1896. „ „ idem. Ibid., for 1895, p. 728.
„ „ „ idem. Comp. Rend. Zool. Leyden, p. 504.
1897. „ „ idem. La Cellule, xii, p. 177, pls. i—iii.
„ „ „ Michaelsen. Polych. deutsch. Meere, pp. 40 and 142, Taf. i, fig. 18.
1898. „ „ idem. Grönland. Annel., p. 128.
„ „ „ De St. Joseph. Ann. Sc. nat., 8e sér., t. v, p. 397.
1899. „ *filiformis,* Ogneff. Biol. Centralblatt., xix, p. 136.
1900. *Ammochares assimilis,* Watson. Journ. Linn. Soc., Zool., vol. xxviii, p. 259, pl. xxiii, fig. 4*a*.
1901. *Owenia fusiformis,* Ehlers. Polych. Magell. u. Chil., p. 193.
1904. „ „ Journ. M. B. A., vol. vii, p. 228.
1907. „ „ Ehlers. Abhandl. Königl. Gesell. Wiss. Göttingen, Bd. v, p. 26.
1909. „ „ Fauvel. Bull. Inst. Ocean., no. 142, p. 17.
1910. „ „ Elwes. Journ. M. B. A., vol. ix, p. 62.
1911. „ „ Bernardi. Arch. Zool. Nap., vol. 5, p. 112.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 106.

Habitat.—Abundant in the deeper water of St. Andrews Bay; in the stomachs of cod, haddock, and "flounder" in the same bay (E. M.). Near low-water mark, Southport Sands (Carrington and W. C. M.). Dredged in the Minch and off Shetland (Dr. Gwyn Jeffreys); Blacksod Bay (Southern).

Station 8, 'Knight Errant,' August 22nd, 1882, in 640 fathoms; 30—40 fathoms,

and 165 fathoms, Dingle Bay, Ireland, 'Porcupine,' 1869, on muddy sand; Bantry Bay, 3½ fathoms; Kenmare, south-west Ireland, log 55 (Royal Irish Acad.); 15—65 fathoms, fifteen miles west of Valentia, May 16th, 1870; 80—100 fathoms, St. Magnus Bay, 1867–68 (J. G. J.); Plymouth (Spence Bate, Rowe, and Allen); Torquay (Elwes); Firth of Forth (Cunningham and Ramage).

Elsewhere it has occurred in the Atlantic; 'Valorous,' Station 16, 1785 fathoms. Mediterranean; Naples (Delle Chiaje, Grube, Bernardi, Claparède), Lo Bianco found it most frequent in water of some depth; shores of France, shallow water, Concarneau (De St. Joseph); North Sea and shores of Norway; Japan (Drasche); Atlantic Coast of New England, United States of America, probably (Verrill); New Zealand (Ehlers); Magellan, etc. (Ehlers); Greenland (McIntosh, Michaelsen).

The cephalic region (Plate CI, figs. 8 *a*—8 *d*) varies in appearance when viewed antero-posteriorly in spirit preparations, but in general it presents a truncated surface, having dorsally a rounded elevation, the longer diameter of which is transverse; and Arnold Watson describes an aperture through a network of muscular fibres at the convex median part of this anterior lip, establishing communication between the cœlom and the exterior, a condition exceptional in the Polychæta, though present in the Euchybræidæ. Beneath this laterally are two lobes or lips, sometimes marked by an oblique groove slanting from above downward and inward, and having the mouth at their anterior border. A bilobed process (the Lippen-organ of Drasche) projects from the region behind, whilst inferiorly another rounded process occupies the furrow, which is finally bounded ventrally by the smooth border of the rim between the branchial processes. This edge of the cephalic rim slightly recedes in comparison with the dorsal, so that the surface does not form quite a right angle. In lateral view, indeed, the median ventral edge is spout-shaped, though it does not project much. An eye-spot lies on each side, at the base of the branchial process beyond the edge of the spout-like curve.

The cephalic rim carries three pairs of dichotomously-divided branchiæ, the basal regions being large and massive, the distal processes rather short and truncated. These organs have their inner surfaces curved with cilia in life. As Mr. Watson[1] states, "Each has a wide, very flat base and three or four branches which are sub-divided into seven or more twigs, each terminated by two small, rounded, mucus-secreting lobes. In British specimens the branchial processes, viewed by transmitted light, are semitransparent, pale greenish-blue or yellow, and tinted with red; whilst those from Naples are blood-red and in parts coloured with a reddish-brown pigment." The Scotch specimens have a pale brown body, paler posteriorly, and the tentacles are brown.

The branchiæ have only a notch between them dorsally, but ventrally a considerable interval occurs at the slightly spout-shaped region below the mouth. These organs are richly vascular. Claparède, Cunningham, and Ramage suggest that they are merely outgrowths from the periphery of the mouth, and are not homologous with the branchiæ of the Serpulids.

Surrounding the circlet of branchiæ is a fold or collar of the body-wall, deepest dorsally and becoming shallow at the ventral edge. A slight fold or notch occurs at

[1] 'Journ. Linn. Soc.,' vol. xxviii. p. 231.

each side with a groove running a short distance backward and nearly opposite the interval between the median and ventral branchiæ. A transverse patch of brown pigment marks the collar dorsally, and passes to the eye-spot on each side, from which it slopes to meet its fellow of the opposite side in the mid-ventral line about the level of the first bristle-bundles. Drasche and Watson show that this pigment indicates the position of the brain and œsophageal commissures which unite to form the ganglion from which the ventral cord, which is devoid of ganglia or neural canals, arises.

The *body* varies from 30 to 60 mm. in length, is firm and rounded anteriorly, somewhat flattened and tapered posteriorly, where it ends in a slightly bilobed tip, with the anus in the centre; the condition perhaps being more accurately described as a papillose anus with a dimple in the centre dorsally and ventrally. The segments, which are indistinctly defined, are from twenty-three to thirty in number, and vary remarkably in antero-posterior diameter. The first region of the body, which commences with the madder-brown collar, consists of the buccal and three bristled segments, as pointed out by Kölliker in 1864, and the author in 1869, and not of two, as Grube, Claparède and Lo Bianco supposed, the smaller posterior pair, which is more dorsal in position, having been overlooked, or, as Claparède states, is the dorsal fascicle pertaining to the first pair of tori. These bristles have a fine, pale, golden lustre, and the row or tuft stands more or less vertically, the longest and most finely tapered being dorsal. All are simple tapering bristles (Plate CX, fig. 9), and the pinnate spikes slant upward—that is, toward the tip. The first pair is lateral in position and is about equidistant between the collar and the second pair, with which it agrees in general arrangement. The third pair is not visible from the ventral surface, being dorsal in position; it springs a little in front of the segment-junction, and is directed obliquely upward and outward. Its bristles have the same structure as those in front, but the function probably differs.

Dorsally the anterior region presents a long, shield-shaped central area, the broad part of which is in front, and the sides are outlined by two frilled hypodermic bands, which pass to the front of the third segment. Ventrally immediately behind the mouth is a triangular area, specially alluded to by Mr. Arnold Watson, bounded by the line of the nerve-cords, which slant inward from each side to form the fused central band along this surface to the tail.

A septum divides the buccal from the following segment, but the three bristled segments form a single chamber. Each of the segments of the posterior region—that is, after the third bristled segment—is separated from the adjoining one by a septum (Watson).

The œsophagus is about the length of the anterior region, and is followed by the intestine, which passes to the anus, a series of enlargements and constrictions occurring during its course. De St. Joseph describes the colour of the canal in the third and fourth posterior segments as greenish from glands. The gut has a dorsal and a ventral mesentery. It is surrounded by the dorsal blood-vessel throughout the greater part of its length, thus forming a peri-intestinal sinus (Watson). This bifurcates anteriorly near the branchial region, bends downward, and unites with its fellow to form the ventral vessel, which has numerous round ampullæ, as many as forty occurring in the third posterior segment (De St. Joseph).

There are six, sometimes seven, pairs of cylindrical, rigid, thread-secreting glands of

considerable size, which hang loosely in the body-cavity—a pair to each of the first and second anterior segments,[1] and the first four posterior segments. Each is attached to the body-wall by one extremity, which forms a duct opening between the end of the torus and the bundle of bristles of the segment to which it pertains (Watson). These secrete a thick viscous liquid, containing fine colourless threads, used in the formation of the inner lining of its tube. De St. Joseph found a minute distome fixed to one of the glands.

The septa, as pointed out by Gilson, have two valves, viz. a simple slit or flap-valve dorsally, opening forward like a door, and a sphincter valve ventrally. Watson noticed that the forward current passed through the dorsal valves, and the backward current of cœlomic fluid through the ventral. These valves are specially powerful in the septum separating the anterior from the posterior region.

The next three segments are comparatively long, each being about twice the length of the anterior region of three segments. The first of these (the fourth bristled segment) has two dorsal bristle-tufts immediately behind its anterior border and two tori for hooks ventrally in the same line as the bristle-tufts. Two glandular bands pass dorso-laterally from the bristle-tufts to those of the succeeding segment, curving inward as they approach the bristles. The ventral surface is marked only by the grooved median band. The next two segments follow the same arrangement dorsally and ventrally. Watson describes an olive-green, zig-zag canal as running almost from end to end of the second segment of the posterior region, and this is the nephridium of Gilson, for it has an internal funnel-shaped opening, and a slit-like aperture externally. He found, however, that it does not transmit the genital products as Gilson supposed. The seventh bristled segment is shorter, but it also presents the same glandular bands dorsally, the dorsal bristles in front of this segment and at its rear being nearer each other, and the posterior pair in front of the tori. The following or eighth bristled segment inaugurates a change, for it has no dorsal glandular bands, and posteriorly it is separated from the next segment by a deep furrow, in front of which are the tori, the edges of which are dorsal, and the bristles, like those in front, are near each other. Moreover, a couple of dimples occur anteriorly on each side of the middle line. Further, if it be held that the anterior segments have their tori and bristles in front, then this segment (eighth) has a double series, those in rear being in front of the segment-junction, and the bristles slant upward and forward. The following segments bear the dorsal bristles on the outer edge and widely apart from each other, and the tori are ventral in position. The direction of the bristle-tufts after the eleventh abdominal segment is usually in the preparations more or less transverse. Moreover, these posterior bristles—even to the tip of the tail—are lateral in position. The segments gradually diminish in antero-posterior diameter toward the tail, which is terminated by a comparatively large anus with a papillose margin, a few of the minute segments adjoining it apparently having no bristles.

The bristles throughout have the same structure, and are slightly pinnate at the extremity (Watson), those in the posterior segments being fewer in number and proportionally longer and more slender. The tori form characteristic bands of a multitude of minute hooks (Plate CX, figs. 9*a* and 9*b*) forming a rasp-like series, each individual with two well-marked hooks, the posterior curve of which is prominent at the

[1] Gilson indicates a rudimentary gland in the third anterior segment. It is sometimes absent.

tip, the neck, which is narrowed, having a forward bulge anteriorly below the hooks, and with a shoulder as it joins the shaft, which is long and slightly tapered posteriorly to a delicate thread.[1] The hooks of the specimens from St. Andrews are somewhat larger than those of the more bulky annelids from Naples, but precisely of the same structure, and thus differ from the somewhat abrupt posterior end at its junction with the ligament, as shown by Arnold Watson, the figure having probably been foreshortened to suit the plate. All have a long shaft gradually tapering toward the base and a distinct shoulder grasped by the epiderm. The absence of a shoulder in the figure of Sars may have been due to the imperfection of his microscope. The tori of the first four segments are red from their vascularity (Watson), and the anterior ones almost meet in the central line ventrally, and reach as far as the bristles dorsally, so that they form the greater part of a ring.

The tube, which varies from 3 to 10 cm., and 2 or more mm. in diameter, as a rule consists of a thick internal lining of secretion, which in the centre presents a circular lumen in section, and of two conical, elastic membranous ends, each with a minute aperture. The body of the tube is densely covered with fragments of shell, more or less set on edge, and in the preparations generally sloped slightly toward the anterior end of the tube. The method by which the annelid accomplishes this is graphically described by Arnold Watson. The fragments are sought out on the bottom by the bilobed tips of the branchiæ, to the mucus on which they adhere or are grasped by them and "worked into the horse-shoe-shaped internal hollow, which, as a ciliated channel, conveys them to the base of the crown" and subsequently to the "Lippen-organ." If suitable it is first rubbed or licked by the latter, then the thin edge of the fragment is turned upward, the "Lippen-organ" rises with it until its bilobed extremity projects between the ventral tentacles, and the fragment is placed on the projecting pouch of the ventral triangular area behind the spout-shaped process. By the action of the "Lippen-organ" and this projecting triangular area the fragment is placed vertically on the elastic conical sheath of the tube, glued thereto by cement from the glandular "Lippen-organ." It would appear that the external thickening of the membranous tube is due to the same secretion, whilst the sheath itself is formed from within, as the imbricated arrangement, for instance, of the posterior end clearly shows. Watson noticed that the secretion of the first two pairs of thread-glands and the long cells of the "Lippen-organ" strongly resist stains, whereas the secretion of the thread-glands of the posterior region stains more easily. The annelid can readily reproduce the anterior conical cap of the tube by the secretion of the thread-glands of the anterior region as well as the glands of the "Lippen-organ," and it also frequently cuts off portions of the tube by acting on the inner membranous portion and by aid of the tentacles and "Lippen-organ" bursting it off. Watson also points out that the tube, though fairly tough during life, speedily decomposes after the death or expulsion of the animal, which usually dies when removed from it; yet those in the stomachs of fishes remain as tough as in life. A ball of sand, loosely held together by mucus (probably secreted by the tentacles), generally invests the naked tube posteriorly. The position of the shell-fragments on the tube offers great resistance to the raising of the tube in the sand, hence the necessity for considerable muscular exertion

[1] De St. Joseph calculates that there are about 7,600 hooks *per torus*, and perhaps about 450,000 in all.

and the multitude of hooks for grasping the inner lining, and thus enabling the animal to screw it upwards (Watson). The tube readily stretches in the living form, the grains or fragments being sloped in extension and erected in contraction. Besides leaving the sand and dragging the tube on the surface, it may be exposed by storms; at any rate large numbers are occasionally found in the stomachs of cod, haddocks, and flounders at St. Andrews. In re-entering the sand the animal reverses its position in the tube, makes a battering-ram of its tentacles, which are twisted into a conical mass, and aided by the "Lippen-organ" soon introduces the end of the tube, and enables it to be screwed into the sand.

Mr. Arnold Watson observes that the imbrication of the constituents of the tubes was not so noticeable in the Neapolitan examples, which were chiefly covered with fragments of black material not sufficiently thin and flat for this purpose.

Considerable variety occurs in the structure of the tubes. Thus in some, fragments of the spines of echinoderms, chiefly of Spatangoids, of the tests of heart-urchins, pieces of the tubes of *Ditrypa*, and fragments of Balani are found. Remarkably coarse tubes came from 40 fathoms off Bantry Bay, where the bottom is evidently composed of broken shells.

The tubes of those dredged at 640 fathoms by the 'Knight Errant' are largely composed of Globigerinæ and sand-grains, besides being hirsute with sponge-spicules which entangle mucus. The posterior end of the tube is coated with the extraneous organisms, only the conical anterior end being free. Sometimes the tubes are white and long, as in 4 to 5 fathoms off Balta (J. G. Jeffreys). A tube, fully six inches in length, occurred between tide-marks at Lochmaddy, North Uist, and of a variegated hue, hornblende being mingled with fragments of white shells, whilst the inner lining was dense. In this case the tube is narrow and long, and the imbricated condition of the external coating is less typical. Unfortunately no tentacular crown is present in the specimen.

Young forms use finer particles, and their tubes are sometimes proportionately long and narrow.

Accompanying the tubes of *Owenia*, covered with translucent sand-grains and Foraminifera, in the 'Valorous' Expedition of 1875, was a cylindrical growth of *Alcyonidium*, which closely resembled such a tube, even to the slightly tapered ends.

Reproduction.—The sexual elements are developed as usual, viz. on the branches of the ventral blood-vessel, and shed into the cœlomic space. Their escape from the body-cavity was supposed by Gilson to be by the epithelial canal on the dorsum of the second abdominal segment (sixth), but Arnold Watson discovered that in May both male and female elements are discharged by two pores to the right and left of the vent—a portion of the posterior end of the body in the males projecting from the anterior aperture of the tube. The ova are enveloped in a gelatinous mass placed near the tube. As in the Nemerteans the stimulus of the emission of sperms is sufficient to cause the females to deposit their ova. The anal pores through which the ova are discharged have their walls lined with cylindrical transparent cells, which may secrete the gelatinous substance.

In an example dredged by the 'Knight Errant' in 640 fathoms, at Station 8 (Atlantic ?) the perivisceral cavity contained many large ova about the size of the Globigerinæ on the wall of the tube, but of a yellow colour.

Mr. Watson followed the development of the ova to the Mitraria-stage. On the

second day they had reached the morula-stage. On the third and fourth days the larva is a Mitraria, and soon becomes an active free-swimming form, appearing in the various tow-nets in St. Andrews Bay, in May and June.

Habits.—The species is gregarious, occurring in numbers near the surface of the sand, as at Southport, at low-water mark. Fauvel and Watson have kept specimens for years in small aquaria, without change of sea-water, so that they are hardy—muddy sand being, it is said, almost as important as abundance of oxygen. The tubes are buried in the sand in a definite direction, each end having a minute aperture, and the animals can reverse themselves in the tube, and invarably eject the excreta into the surrounding water from the anterior end, which is near the surface. The tube can be moved by the animal, as, for instance, when burrowing in the sand.

Claparède (1868) stoutly maintained the priority of Delle Chiaje's title, *Owenia filiformis*, notwithstanding that the Neapolitan author only gave figures and a title, for the accuracy of the figure in most respects is, he said, more valuable than a feeble description. Claparède calculated that there were 10,000 hooks in each segment, and no less than 150,000 in the whole animal, a considerably lower computation than that of De St. Joseph. The author describes the numerous branches of the blood-vessel, which in the long segments number thirty-five pairs, and have ampullæ or dilatations at their commencement. All these debouch into the great dorsal vessel, which surrounds the alimentary canal as far forward as the first torus. Delle Chiaje described a single pair of secretory glands which traversed the segments, and Kölliker thought that a pair occurred in each segment. Claparède, however, found four pairs of tube-secreting glands in the Neapolitan examples, the first opening behind the capillary bristles of the first segment. On the other hand, Eisig maintains that *fusiformis* and not *filiformis* is the correct specific name, since the latter was given in error by the Neapolitan author himself. In Claparède's last (posthumous) publication (1873) he gives a section of the body-wall, and shows a gland on each side dorsally at the base of the bristle-tufts, whilst the cœlom is distended with large ova.[1]

Verrill[2] (1879) includes both *Ammochares assimilis* and *Owenia filiformis*, Delle Chiaje, but there is a misapprehension, for the names are synonymous.

Von Drasche (1885) gave a careful account of the general and minute structure of this species, with excellent figures. He describes the nervous system as consisting of brain, œsophageal ring, and ganglionated cord (Bauchmark), all of which lie in the hypoderm outside the musculature. He locates the brain under the "Lippen-organ," and states that it consists of "Leydig'schen Punkt oder Fasersubstanz" and ganglion-cells, and he gives a figure and description of a "Schlundcommissur" as occurring on the ventral surface—apparently when the cords are approaching each other—about the first bristle-bundle. His figures of the minute structure of the cords are good, but the arrangement of the dorsal and ventral longitudinal muscles, of the alimentary canal, of the mucous glands and blood-vessels, are only briefly alluded to.

Fewkes[3] (1888) found a Mitraria in the Bay of Fundy, but its actual relationships were then unknown. In all probability it is a larval form pertaining to this family.

[1] 'Annel. Sedent.,' pl. viii, fig. 8.

[2] 'Mar. Invert. Atlantic Coast,' Rep. U. S. Comm. Fish and Fisheries, 1879, p. 10.

[3] 'The Microscope,' June, 1888, pp. 1—4, pl. vi.

Gilson [1] (1894) describes a pair or sometimes two pairs of very small nephridial funnels in the posterior part of the sixth segment, passing through the muscular coat, and opening not freely on the surface but into a longitudinal duct, which may at certain places be only an epithelial groove. He thought the ova escaped by it. The same author [2] (1894) thought that the substance which fills the glandular tube (of the filiform glands) is got rid of by a process of oozing through the cellular membrane.

Gilson [3] (1897) further described the septal valves and other features of *Owenia*. The anterior septa have regular openings, which can be occluded by the contraction of the valves, and he connects this, amongst other things, with the absence of the circular muscular coat, except in the short region comprising segments 1 to 4. The septa have strong muscles, and the greater number are associated with invaginations of the epidermis and epidermal tubes. He is of opinion that these muscular septa and valves are intimately associated with the movements of the annelid in its tube, and are hydrodynamic, besides permitting the passage of the genital products. The epithelial tubes give entrance to sea-water, and perhaps afford an exit for cœlomic fluid. The epidermal canal, again, is a provision for the emission of the genital products in the tube at the sixth segment, and it relieves the animal from the dangers of exposing so much of the anterior region for this or other purposes. The theoretical considerations concerning the epithelial tubes, septa, and the canal in the sixth segment need not be considered, and there is some doubt concerning the emission of the reproductive elements.

Arnold Watson (1900) gave an epitome of previous knowledge of the group, and added interesting observations of his own with good figures on the functions of the "Lippen-organ," the structure and the mode of formation of the tube, and on the reproduction and development of *Owenia filiformis*.

Johnson [4] describes an *Ammochares* (*Owenia*), viz. *O. occidentalis*, as having bifid uncini, but this is a general feature.

At Naples, Lo Bianco (1909) found mature specimens from January to June, and similar observations were made by the veteran French observer, De St. Joseph.

Genus CXXXI.—Myriochele, *Malmgren*, 1867.

Head blunt or truncated, devoid of eyes and appendages. Mouth oblique, subventral. Body slender, cylindrical, of two regions. Anterior region has three segments, with three pairs of bristle-bundles only; the succeeding region has bristles and hooks in each segment. Bristles with smooth shafts and spinulose tips; hooks bidentate, forming a file-like, ventral, interrupted belt on the surface of the tori. Tubicolous.

[1] 'Anat. Anzeiger,' Bd. x, p. 191, five text-figs.
[2] 'La Cellule,' t. x, p. 299, one plate.
[3] Ibid., t. xii, p. 377, pls. i—iii.
[4] 'Proc. Bost. Soc. Nat. Hist.,' vol. xxix, p. 420, pl. xiv, figs. 140—142.

1. Myriochele Heeri, *Malmgren*, 1867. Plate CX, figs. 10 and 10 *a*—bristle and hook; Plate CXI, figs. 7 and 7 *a*—head and body.

Specific Characters.—Head bluntly rounded or slightly enlarged; anterior end obliquely truncated, with the mouth in the centre of the combined cephalic and buccal region. Body of two regions, the anterior of three bristled segments, which differ from those of *Owenia* in so far as all the bristles project laterally. The second region is more or less cylindrical anteriorly, a little narrowed posteriorly, and ending in a slightly tapering tail, with the anus in the centre. Setigerous segments about twenty-seven, the fascicles of bristles becoming longer posteriorly, and all having sparse spikes distally —directed toward the tip. The tori are crowded with bifid hooks.

Tube from 2 to 4 in. in length, the anterior end slightly tapered, and the posterior extended as a long and often flattened process. It is composed of sand-grains on a lining of secretion, and often has a ferruginous hue, but this mainly depends on the site, as some have mixed white and black sand-grains, and other minute fragments of shells which are set on edge in contracted examples.

Synonyms.

1867. *Psammocollus*, Grube. Novara-Annel., p. 30, and Annul. Semperiana, p. 203.
„ *Myriochele Heeri*, Malmgren. Annul. Polych., p. 101, Taf. vii, fig. 37.
1875. „ „ Ehlers. Zeitschr. f. wiss. Zool., Bd. xxv, p. 27.
1879. „ „ Tauber. Annul. Danica, p. 125.
1880. „ „ Langerhans. Zeitschr. f. wiss. Zool., Bd. xxxiv, p. 104.
1882. ? „ *Sarsi*, Hansen. Norske Nord.-Exped., p. 41, Taf. vi, figs. 6—11.
„ „ *Danielsseni*, idem. Ibid., p. 42, Taf. vi, figs. 13—14.
1883. „ *Heeri*, idem. Vidensk. Meddel. Nat. For., p. 148.
1885. „ „ McIntosh. 'Challenger' Annel., p. 410, pl. xxv *a*, fig. 14.
1886. „ „ Levinsen. Kara-Havets, etc., p. 11.
1893. „ „ idem. Kanonb. "Hauchs," p. 345.
1897. „ „ Michaelsen. Polych. deutsch. Meere., p. 144.
1898. „ „ idem. Grönland. Annel., p. 128.
1907. „ „ Fauvel. Bull. Inst. Ocean., t. xix, no. 107, p. 30.
1913. „ „ idem. Bull. Mus. Hist. Nat., no. 2, p. 9.
1914. „ „ Southern. Proc. Roy. Irish Acad., vol. xxxi, no. 47, p. 106.

Habitat.—Stomach of the haddock, St. Andrews Bay, 1864 (E. M.); dredged in Clew Bay, Ireland, in 16 to 17 fathoms, Station W. 155, August, 1910 (Southern)[1]; S.W. Ireland, Station 5, 1885 (Royal Irish Acad.).

Abroad it occurs in Greenland, Spitzbergen, Safehavn, etc. (Malmgren); Spitzbergen (Fauvel); abundant in the Gulf of St. Lawrence, Canada, Station No. 9, 35—42, 1873 (coll. Dr. Whiteaves); Madeira, 30 fathoms (Langerhans); ? North Atlantic (Hansen).

Head and buccal segment (Plate CXI, figs. 7 and 7 *a*) are often somewhat enlarged in lateral view, whilst from the dorsum they form a bluntly-clavate process with a constriction behind. In others this region slightly projects all round. The mouth opens on the ventral surface as a large circular aperture immediately behind the tip of the

[1] Mr. Southern kindly forwarded specimens for examination.

snout, and it slopes to a peak ventrally. The cephalic and oral margins are smoothly rounded and composed of ciliated cuticle and a thick glandular hypoderm beneath.

The *body*, so far as observed, for no entire example has been seen, has about twenty-seven segments (Malmgren) divided into an anterior and a posterior region. The anterior region has three pairs of bristle-bundles—all visible at the sides of the body, and thus differing from *Owenia*, where the third pair are dorsal. Each bristle is nearly straight and slightly tapered toward the tip, and has short spikes directed distally (Plate CX, fig. 10).

The succeeding region has both bristles and tori. The former agree with those in front. The hooks (Plate CX, fig. 10*a*) have a posterior projection distally and are bifid. The front edge of the neck inferiorly is prominent, and the neck itself is short, for the shoulder soon appears, whilst the shaft is long and tapers to a filament.

The smooth tube in the Canadian example is nearly 4 in. in length, the anterior third being spindle-shaped and prolonged posteriorly into a narrow process, thus differing from the tube of *Owenia*. It is composed of sand-grains incorporated in a very tough secretion, which also lines it internally, and to it the animal in the preserved condition clings so firmly that it is difficult to secure more than a fragment. The anterior end forms a conical process with a small aperture at the tip, but only the extremity is free from sand-grains. Posteriorly the long narrow tube ends in an aperture, and whilst the greater part of it is covered with the sand-grains in tough secretion, the terminal region, which is almost filiform, is coated with soft sandy mud, which often forms a mass at the tip. The external coating is composed of firmly agglutinated mud in which large sand-grains are imbedded, and occasionally a few tufts of *Gemellaria* are attached near the anterior end, the larvæ having settled and grown thereon. In many the wrinkles and the grains are transversely arranged on the anterior or larger portion of the tube, the long, slender, posterior end not showing this feature. In those with shorter tubes the sand-grains on the other hand go to the posterior end.

A few tubes are formed of white sand-grains with black interspersed. Tubes from Norway apparently belonging to this species were bristled with sponge-spicules.

A *Myriochele* was found at St. Andrews in the stomach of a haddock in 1864 by E.M. invested by a sandy tube. So far as can be observed in the fragmentary specimens the arrangement of the bristles and the structure of the bifid hooks are identical. The size of the bifid hooks is somewhat larger than in the Canadian form.

The tube in the examples from Clew Bay, which are probably rigidly contracted, is composed of minute fragments of shells, set on edge as in *Owenia*, and grains of sand fixed to a transparent secretion. On the other hand, those from Station 5, South West of Ireland, are formed of very minute grains of fine white sand, the abundance of the species on such grounds apparently indicating the suitability of the surroundings. Unless the animals are extruded from the tubes in life it is difficult to secure an entire example.

Levinsen[1] (1883) is in doubt as to whether the two species described by Hansen, viz. *M. Sarsi* and *M. Danielsseni*, are not identical with the common form.

Fauvel (1907) includes both *M. Sarsi* and *M. Danielsseni* of Hansen under this species, and there is certainly considerable variation.

[1] 'Vidensk. Meddel. Nat. For.,' p. 148.

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BRITISH MARINE ANNELIDS, VOL. III.

Errata.

P. 205, line 16, Plate XCIII, fig. 3, refers to *Polydora cocca*, Œrsted, and the same applies to p. 206, line 20.

P. 242. The description of the Genus *Cirratulus* is :—Head more or less conical, elongated or rounded ; with or without eyes; mouth ventral. Body cylindrical, anterior segments devoid of cirri or branchiæ ; filamentous tentacles and branchiæ arise nearly simultaneously ; bristles in both divisions of the foot anteriorly, then crotchets appear ventrally, and by-and-by dorsally.

The plates to illustrate this volume will form Part II. Having been executed abroad, it has not been possible to obtain them up to the present time on account of the war.

December, 1914.

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